VISIT…

SECTION 20

FASTENING & JOINING

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Fastening Studs and Pins to Plates

Ten removable and five permanent methods for fastening studs that provide pivots for linkages, act as stop pins, or register of parts in assembly.

D. Mascio

REMOVABLE ASSEMBLIES

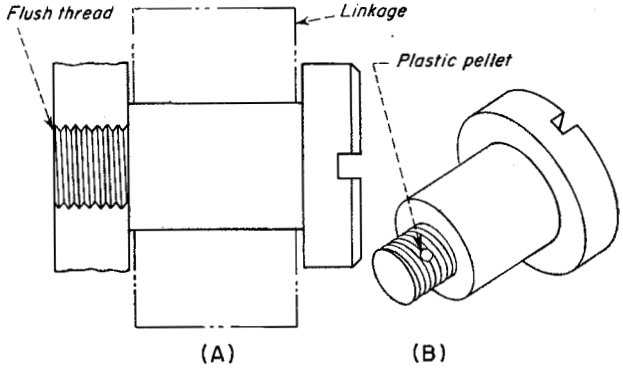


Fig. 1—(A) Shoulder screw in threaded hole may have slotted head. Thickness of mounting plate should be at least equal to thread diameter—especially if design does not allow thread to protrude or to be cut flush. (B) Loosening of screw can be prevented by having plastic pellet inserted into body of thread, or patented, self-locking threads.

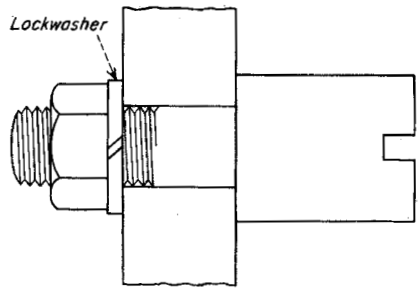


Fig. 2—Shoulder screw in unthreaded hole requires nut and washer. Plate can be any thickness. Loosening of screw is prevented by lock washer or by using a lock nut.

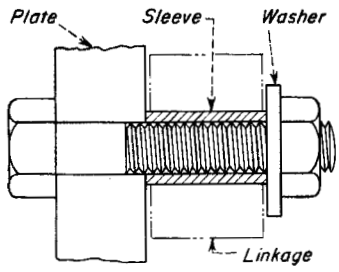


Fig. 3—Standard bolt and nut can be used to hold movable linkage by using sleeve to prevent binding when screw is tightened..

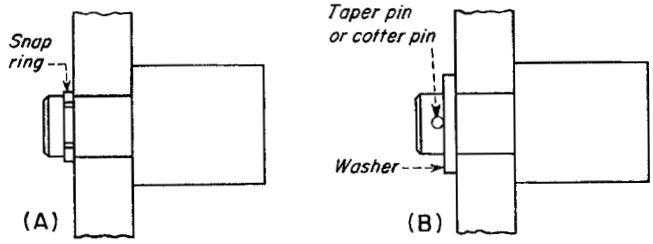


Fig. 4—Where end play is permissible, stud can be retained by (A) unthreaded shoulder pin and snap ring; (B) washer and cotter or taper pin. Wedging effect of taper pin prevents end play if pin is properly located.

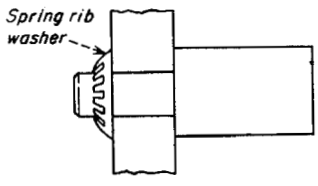


Fig. 5—Quick assembly is obtained with spring rib washer but slippage may occur with high loads. Also stud is difficult to disassemble.

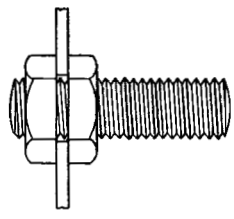


Fig. 6—Threaded rod provides for axial adjustment in sheet metal assemblies by clamping plate between two nuts (usually lock nuts).

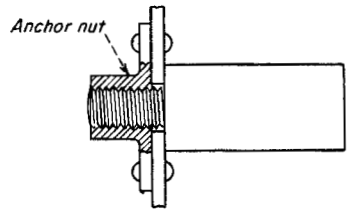


Fig. 7—Anchor nut enables shouldered stud to thread into thin sheet metal when only one side of plate is accessible.

REMOVABLE ASSEMBLIES

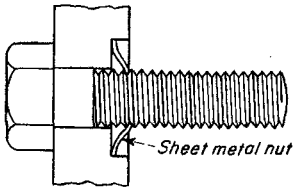


Fig. 8—Sheet metal nut and standard screw make simple fastening for small mechanism assemblies. Nut can be recessed.

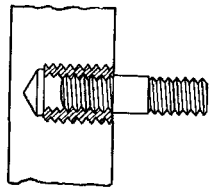


Fig. 9—Inserts with tapped hole provide seat in plastic or soft metal for standard stud threaded on both ends. Inserts are retained in plate by various patented methods.

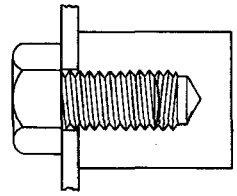


Fig. 10—Stud with tapped hole is retained in thin sheet metal with standard screw. Hole can be tapped all the way through.

PERMANENT ASSEMBLIES

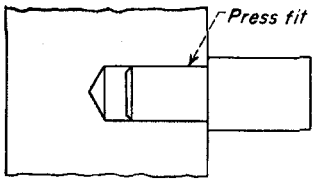


Fig. 11—(A) Shoulder stud is pressed into hole in plate. Holding power can be improved by using brazing ring or (B) having groove pressed on the shank by licensed manufacturers.

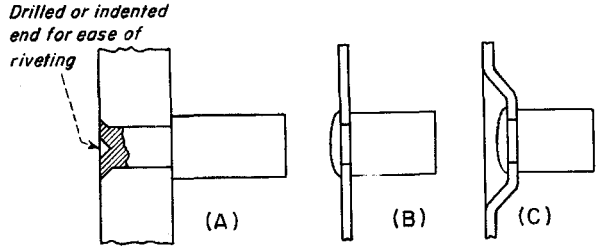


Fig. 12—(A) Riveted shoulder stud in clearance hole is center drilled for ease of riveting. Plate countersunk for flush riveting. (B) Riveting over sheet metal will not be flush unless (C) metal is indented.

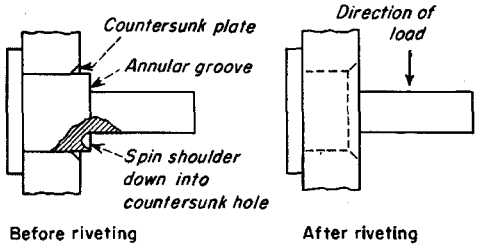


Fig. 13—Stepped-up stud does not reduce shear area at junction of pin and shoulder (as in Fig. 12 A). Therefore, for same pin diameter shear strength is higher. Also, when stud is used as a stop pin, head of stud resists shock loads which may cause stud in Fig 12 (A) to pull out.

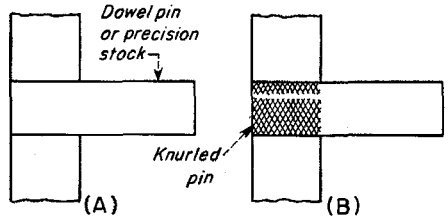


Fig. 14—(A) Press-fitted dowel pins can be used for small sizes up to $\frac{3}{8}$ in. dia.—precision stock for larger diameters. Press fit is also obtained with knurled pin (B) or with patented items such as grooved pins, slotted tubular pins, spirally rolled pins.

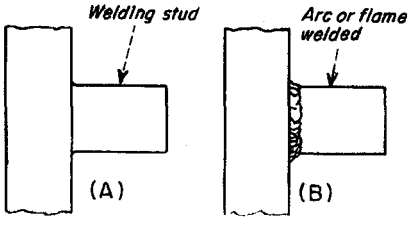
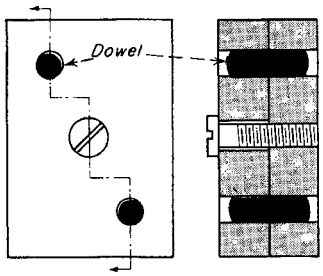


Fig. 15—(A) Special studs for welding allow dissimilar metals to be welded, which is frequently impossible with resistance welding. Special gun for welding creates little heat, therefore no distortion. (B) Flame welded studs have fillet around bottom.

16 Ways to Align Sheets and Plates with One Screw

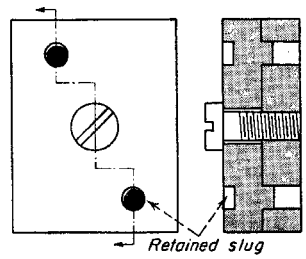
Federico Strasser

Two Flat Parts



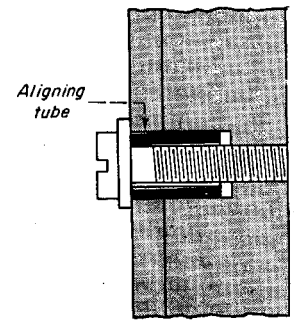
1 Dowels . . .

accurately align two plates, prevent shear stress in fastening screw. Two pins are necessary because screw can not act as aligning-pin.



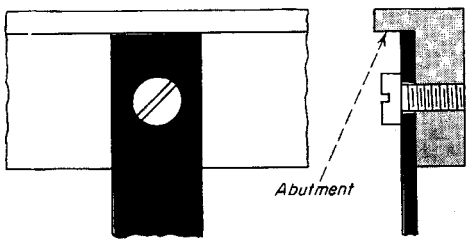
2 Retained slugs . . .

act as pins, perform same function as dowels; are cheaper but not as accurate.



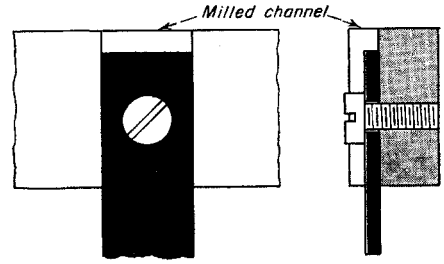
3 Aligning tube . . .

fits into counterbored hole through both parts. Screw clearance must be provided in tube.



4 Abutment . . .

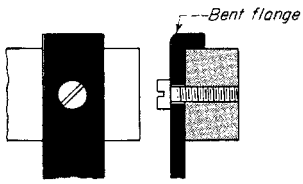
provides positive, cheap alignment of rectangular part.



5 Matching channel . . .

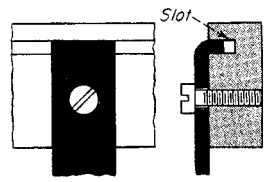
milled in one part gives more efficient alignment than abutment in preceding method.

Formed Stampings Assembled with Flat Parts



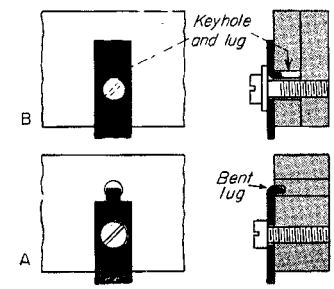
6 Bent flange . . .

performs similar function as abutment, but may be more suitable where machining or casting of abutment in large part is not desirable or practical.



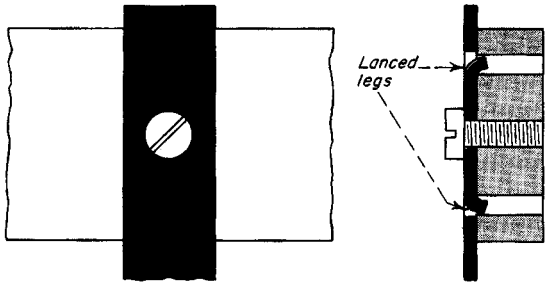
7 Narrow slot . . .

receives flange or leg on sheet metal part, allows it to be mounted remote from edge of other part.

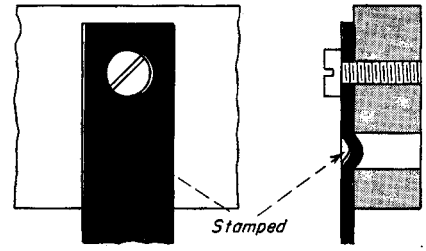


8 Bent lug . . .

(A) fits into hole, aligns parts simply and cheaply; or (B) lug formed by slitting clearance hole in sheet metal keys parts together at keyhole.

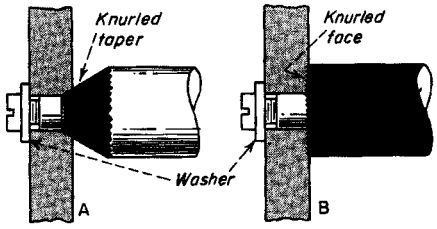


9 Two legs . . .
formed by lancing, align parts in manner similar to retained slugs in method 2, but formed legs are only an alternative for sheet too thin to partially extrude slug.

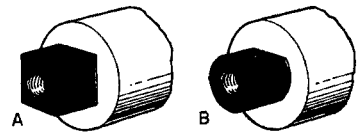


10 Aligning projection . . .
formed by slitting and embossing is good locating method, but allows a relatively large amount of play in the assembly.

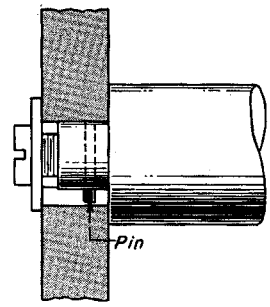
Flat Parts and Bars



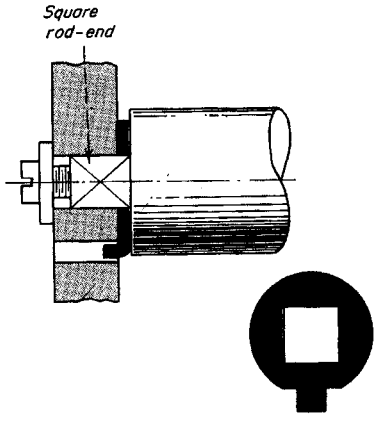
11 Knurled end . . .
of round bar (A) has taper which digs into edge of hole when screw is tightened; this gives accurate angular location of bar or sheet. (B) Radial knurling on shoulder is even more positive.



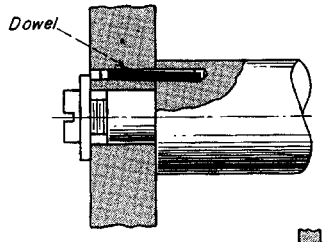
12 Noncircular end . . .
on bar may be square (A) or D-shaped (B) and introduced into a similarly-shaped hole. Screw and washer hold parts together as before.



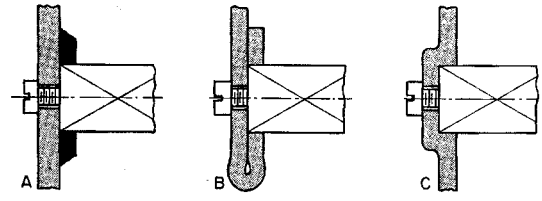
13 Transverse pin . . .
in rod end fits into slot, lets rod end be round but nonrotatable.



14 Washer over square rod end . . .
has leg bent to fit in small hole. Washer hole is square, preventing angular movement when all three parts are assembled and fastened with screw and washer.



15 Dowel . . .
is simple, efficient method of preventing rotation if rod dia is big enough.



16 Double sheet thickness . . .
allows square or hexagonal locating-hole for shaft end to be provided in thin sheet. Extra thickness can be (A) welded (B) folded or (C) embossed.

For Better Grip-Longer Holes in Sheetmetal

In Steel or brass, depth of a threaded hole should be at least half its width, and in zinc or aluminum the right ratio is 2/3. If the metal is too thin, here's what to do.

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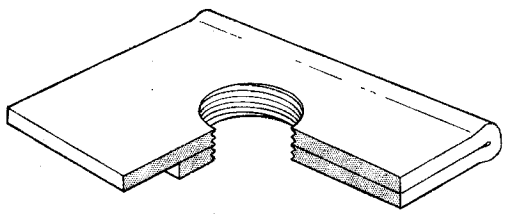
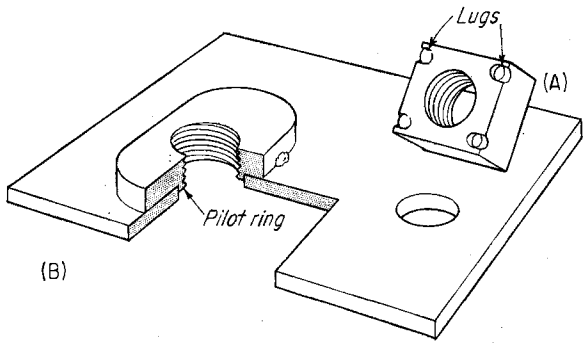


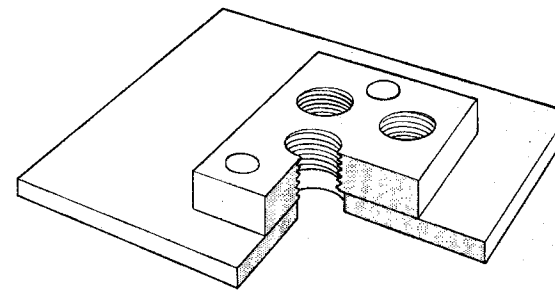
1

BENT-OVER SHEET doubles depth of holes near edge. Sometimes one more bend, for triple depth, is possible.



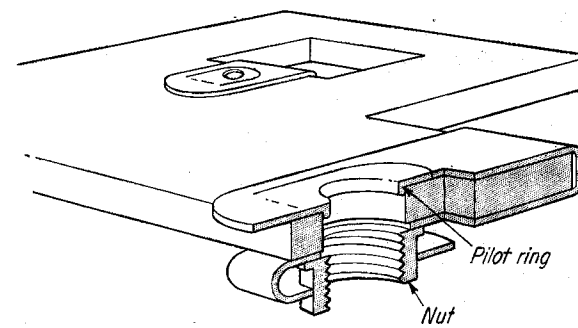
2

PROJECTION-WELDING fuses lugs on nut (A) to sheet. Flanged nut (B) for spotwelding has pilot rim to locate it on hole.



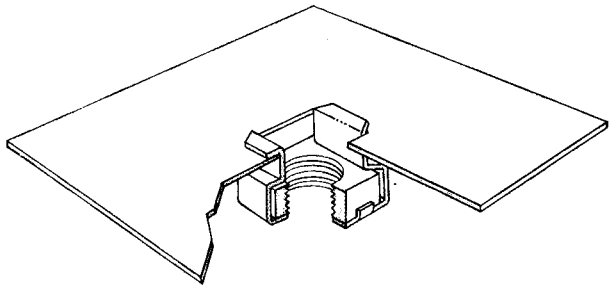
3

PATCH OF SHEET or plate, for a longer thread, serves holes away from edge; needs at least two rivets or welds to keep it from turning. Larger pieces cover group of holes.



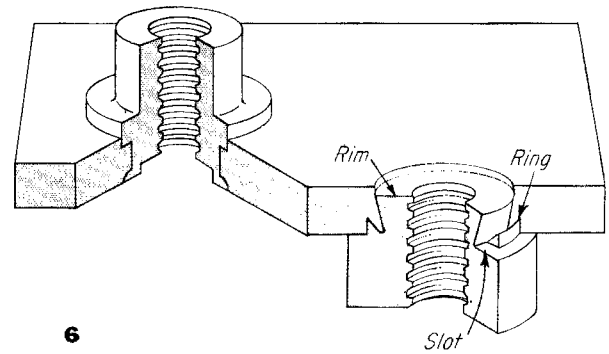
4

CLIP slips over edge of sheet, and positions on hole when pilot rim springs into place. Extra cutout next to hole allows installation away from edge.



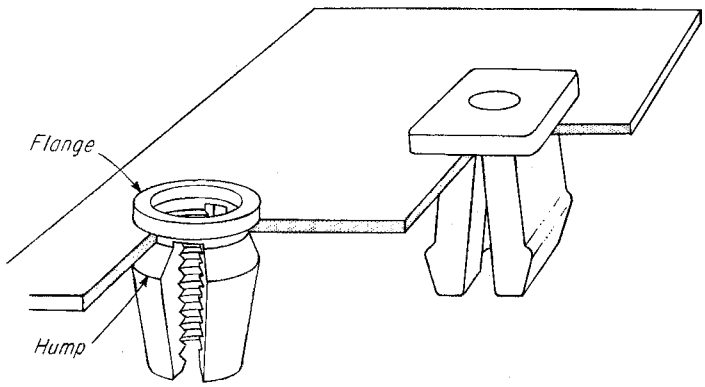
5

FLOATING NUT snaps into square hole and allows misalignment of bolt. If the thread strips, replacement is easy.



6

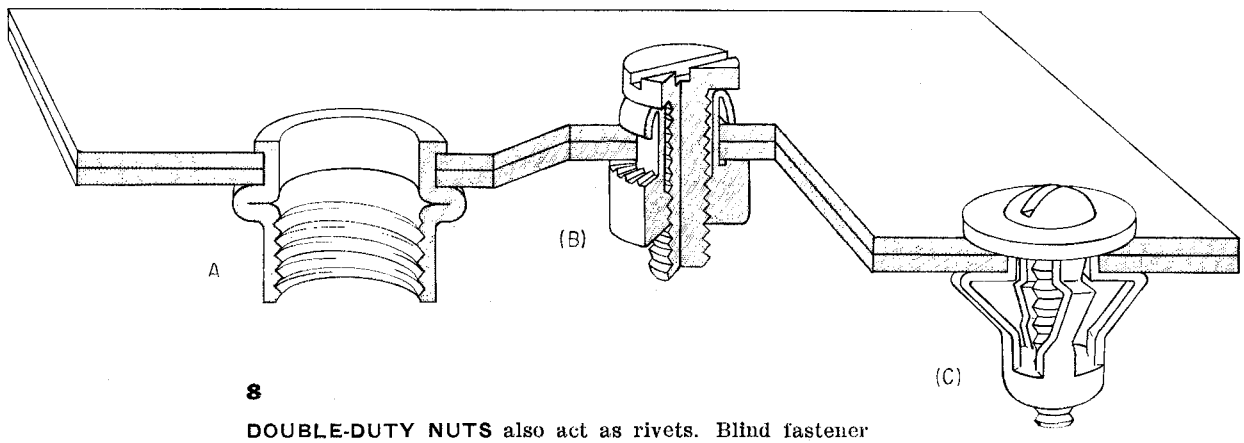
STAKED NUT fits in relieved hole. Relieving nut makes it easier to stake. Squeeze on clinch nut forces sheet to flow under tapered rim. Slots in ring keep nut from turning.



7

TAPPED HOLE snaps into sheet and grips it between flange and hump. Screw forces prongs apart so hump presses even harder on sheet. Slot digs into side of hole to prevent turning. Another version sits flush.

Square-shape plastic grommet, which doubles as insulator, cannot turn in square hole. Screw must make its own threads in smooth grooves, as it wedges grommet tightly in place.



8

DOUBLE-DUTY NUTS also act as rivets. Blind fastener (A) requires special tools; other blind fastener (C) doesn't. Nut (B) bites into sheet when screw tightens down on neck, and bends it over.

Bolts Get Help Against Shear

Especially when they are loose, clamping bolts or screws encounter side loads they weren't meant to carry. Here are ways to stop bending and to align parts as well.

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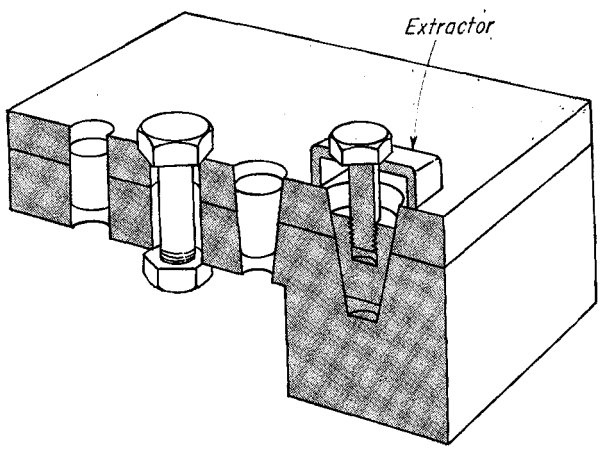
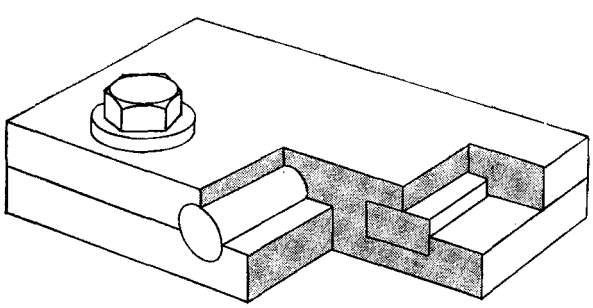
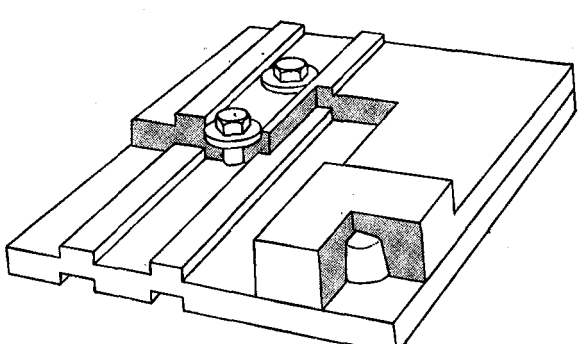


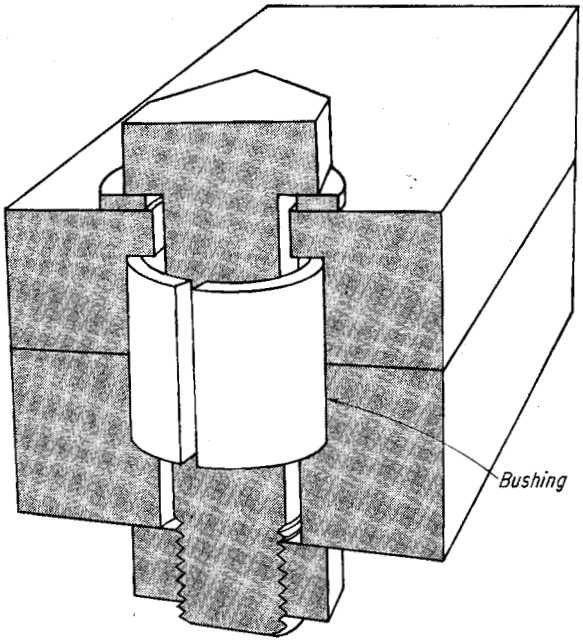
DOWEL PINS hold against small loads at temporary or semi-permanent joints. For joints taken apart more often, use tapered pins; they come out easier. Where a dowel pin fits in a blind hole, it can't be knocked out so must be drilled and tapped to take an extractor. Fancier types carry a threaded rod on top which sticks out of the hole. As a nut is tightened down on it, the pin lifts out.



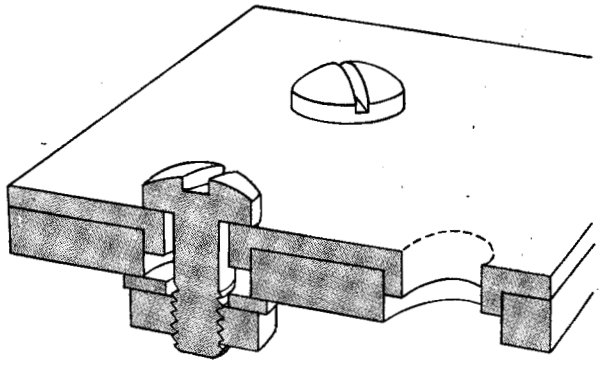
KEY is pin laid flat between two parts. Although round pin is easier to install than the rectangular key, it lets parts shift when the bolts loosen even slightly.



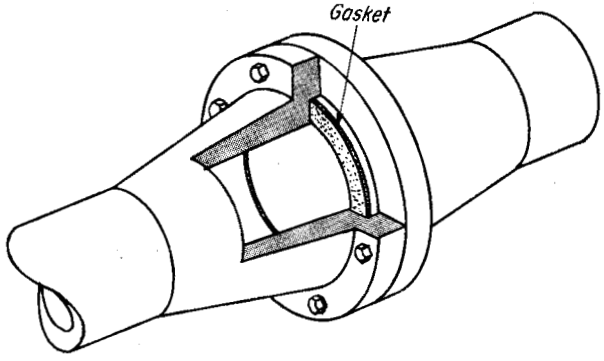
RIBS lock extruded or formed sheets together without further preparation. On cast or molded parts, integral boss fits into hole which is either molded or drilled.



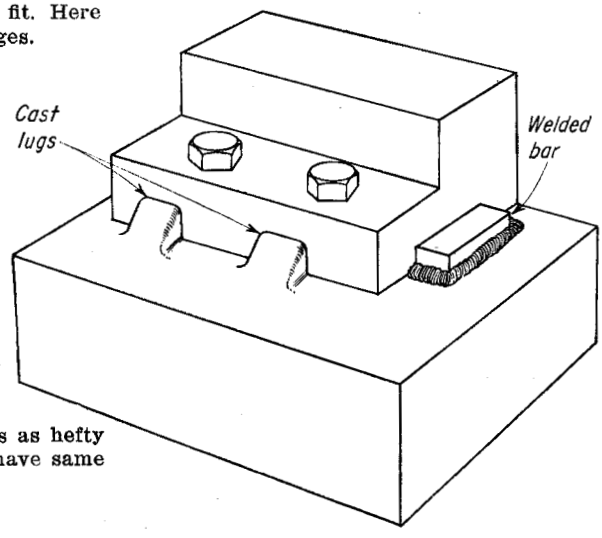
BUSHING is split so that it fits tightly yet doesn't need a reamed hole as a dowel does. Solid bushing replaces it when high side loads would compress a split bushing.



BOSS on extruded hole becomes a built-in bushing when used to locate and hold a sheetmetal part.



RABBET takes high loads and gives precision fit. Here rabbet also locates gasket between pipe flanges.



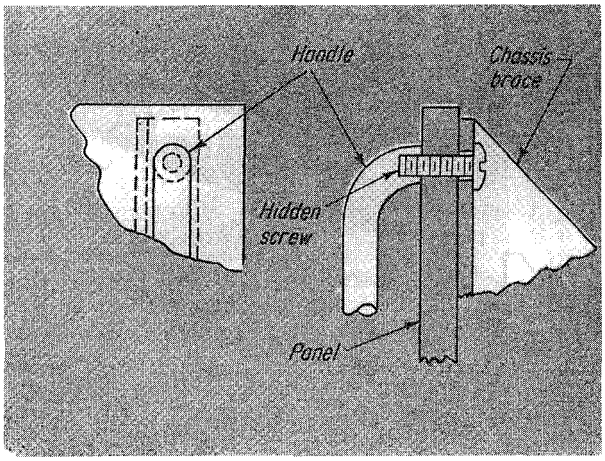
CAST LUGS or welded bars provide shoulders as hefty as a more expensive recess would, but don't have same clean look.

10 Ways to Conceal Fasteners

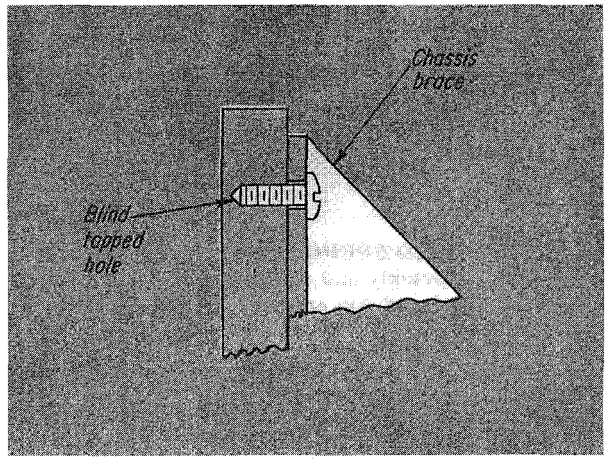
How to improve appearance of instrument panels by hiding screw heads.

Frank William Wood JR

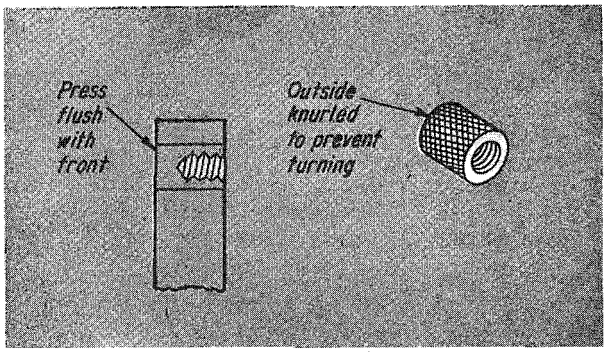
The appearance of an otherwise good-looking instrument panel is often spoiled by screw heads distributed in an uneven pattern across the panel surface. The following designs illustrate methods of improving appearance by subduing and concealing fasteners. In some cases, applications of these designs will not only improve appearance but also will reduce fabricating and assembly costs. Sometimes you get tamper protection as well.



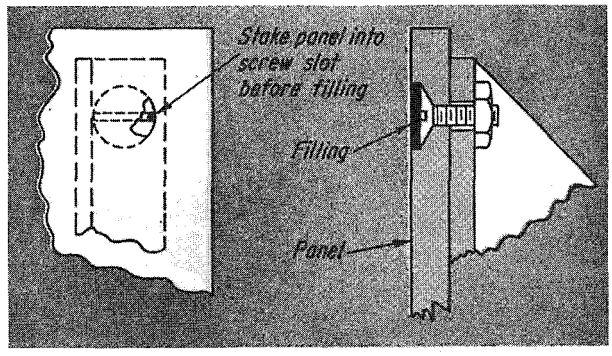
1 **DOUBLE-DUTY SCREW** attaches chassis to panel, is concealed by handle . A bonus is reduced fabrication and assembly time.



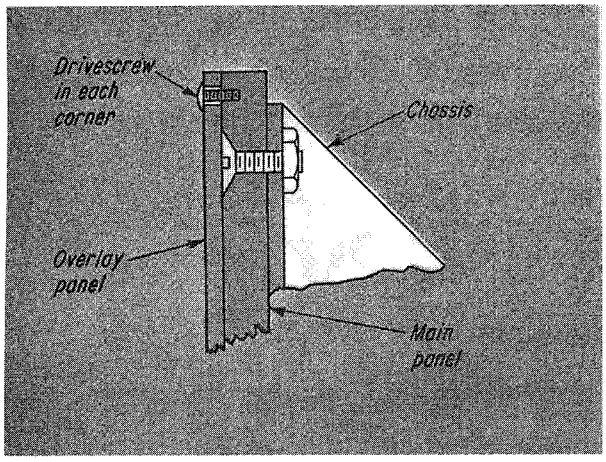
2 **BLIND HOLE** in panel conceals screw. This method is best suited for thicker panels, when adequate depth can be obtained without close tolerances.



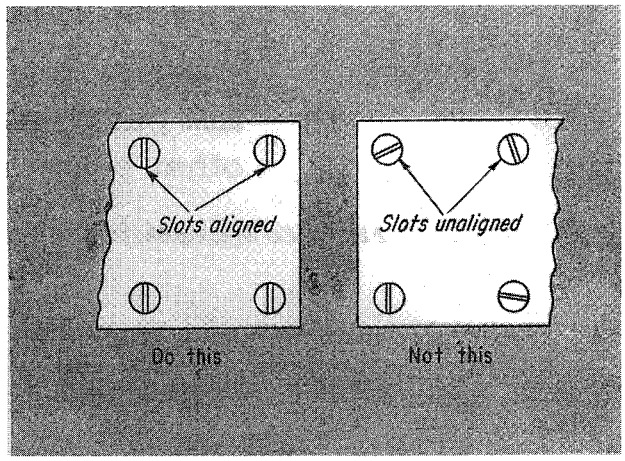
3 **TAPPED INSERT** pressed into panel is sometimes more economical than blind-tapped panel.



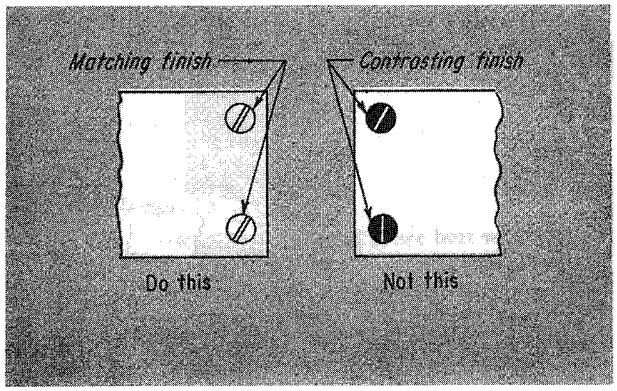
4 **RECESSED SCREW HEAD** is concealed with an epoxy resin before panel finish is applied. To prevent loosening of screw, the panel should be threaded. This thread, in conjunction with staking, locks the screw securely in position.



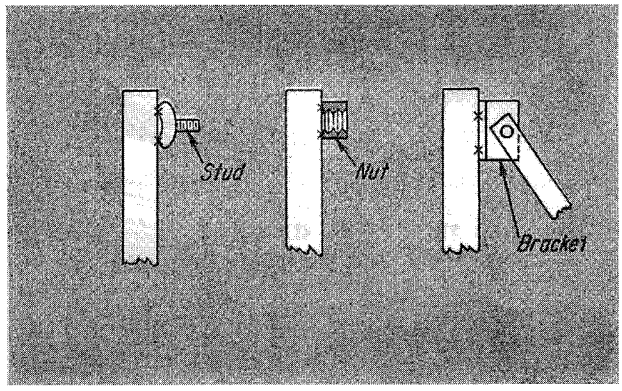
5 **"OVERLAY" PANEL** conceals all front-panel hardware. Overlay panel offers no support for components and in many cases is attached with pressure-sensitive adhesive. All markings and nomenclature for controls can be carried by this panel.



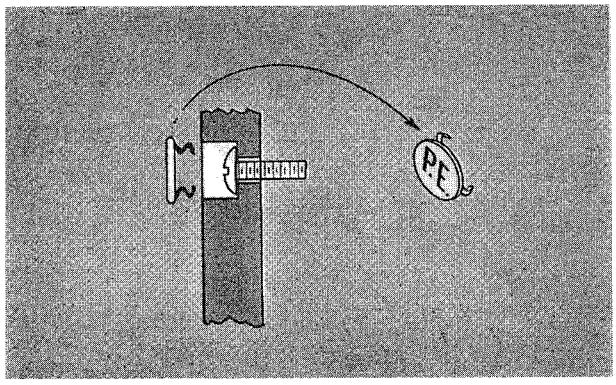
6 **ORIENT SCREW-HEAD SLOTS** in same direction to subdue detracting appearance of screw heads.



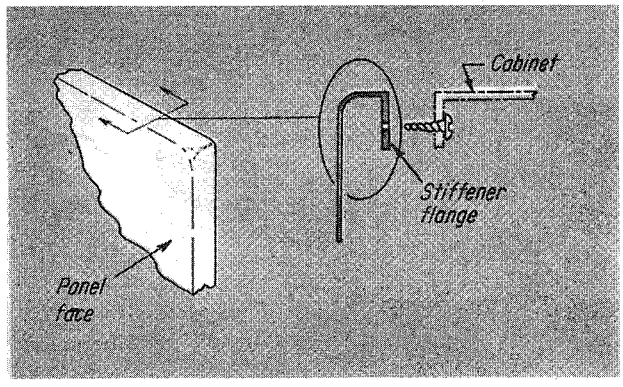
7 **MATCHING HARDWARE FINISH** to that of the panel effectively subdues hardware appearance. A familiar example of this is the black oxide finish commonly used on panel-meter screws.



8 **SPOT-WELDED STUDS AND NUTS** are commercially available for use on steel panels. Or, alternatively, special brackets can be used.



9 **SNAP-IN "PLUG BUTTON"** fits into counterbored recess to conceal screw head and also provide corporate or product identity.



10 **SHEETMETAL STIFFENER FLANGES** can be integral, as shown here, or separate when panel material cannot be formed. Sheetmetal screws hold panel.

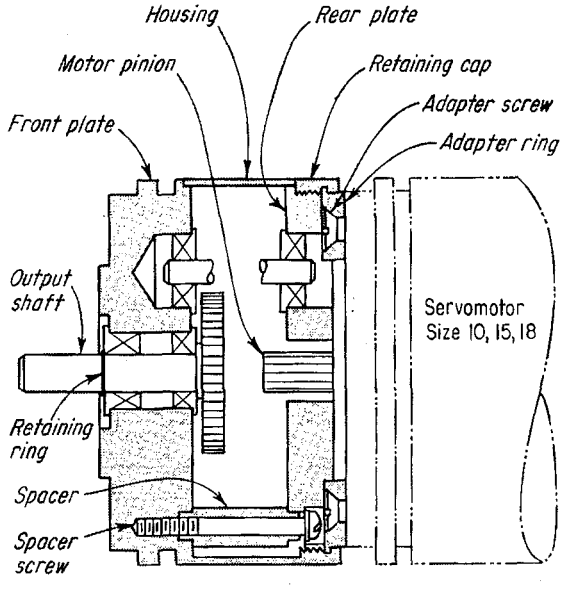
Attaching Motors to Instrument Gearheads

Methods include servoclamps, screws, pins, adapter plates and half-rings, plus an eccentric mounting.

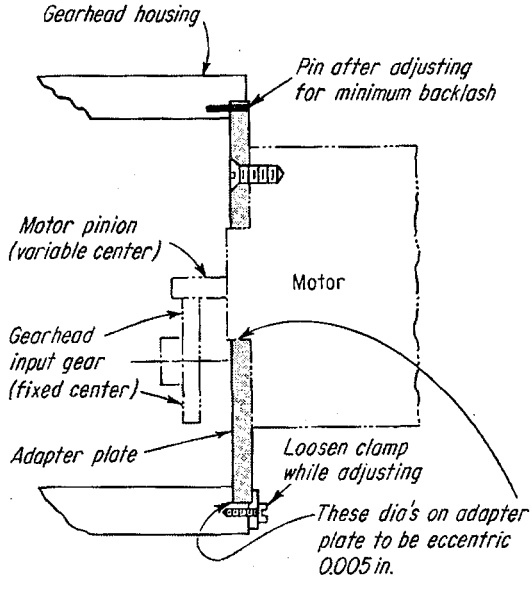
Frank William Wood JR

Instrument gearheads are increasingly useful in complex servo equipment where space is at a premium. Motors to drive the gearheads are usually mounted in line with them and must be reliably and economically attached. Sketches show some of the various methods possible. The method chosen for a particular design is determined by configuration of the motor, the type of input plate on the gearhead, or a combination of both.

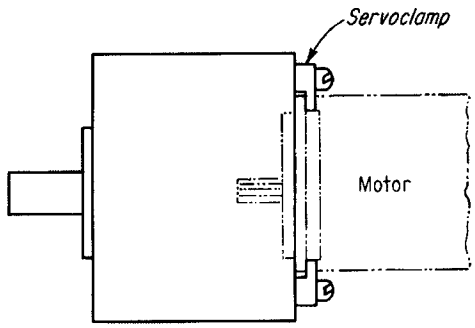
Installation should be simple—it should not require disassembly of gearhead; connection should not loosen under vibration or shock, should not increase diameter of gearhead, should provide adjustment in high-precision requirements, and should provide necessary environmental protection at point of attachment (keep dust, moisture, etc., from entering gearhead). Backlash adjustment is also a desirable feature to include.



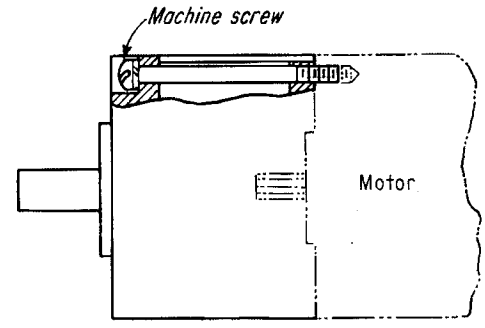
1 TYPICAL GEARHEAD and motor using "plate construction" gearhead.


Gearhead housing
Pin after adjusting for minimum backlash
Motor pinion (variable center)
Motor
Gearhead input gear (fixed center)
Adapter plate
Loosen clamp while adjusting
These dia's on adapter plate to be eccentric 0.005 in.

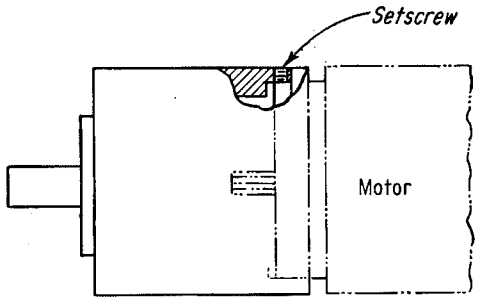
2 MOTOR IS MOUNTED on eccentrically bored adapter plate to permit backlash adjustment. By rotating adapter plate, backlash can be reduced to minimum between motor pinion and gearhead input gear.



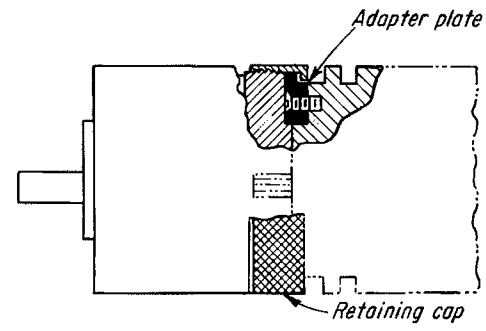
3 STANDARD SERVOCLAMP



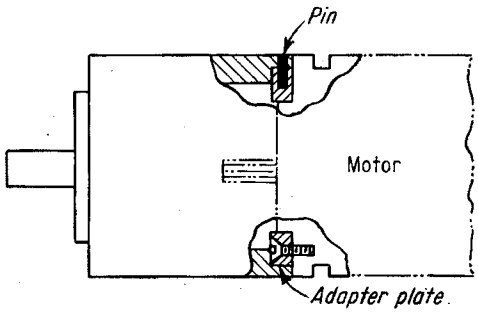
4 BOLT THROUGH GEARHEAD INTO MOTOR



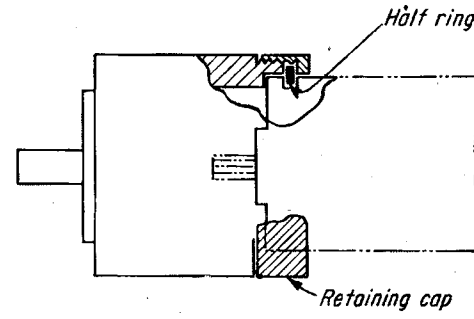
5 SETSCREW THROUGH HOUSING SIDE-CLAMP TO MOTOR



6 ADAPTER PLATE AND RETAINING CAP



7 PIN THROUGH HOUSING SIDE INTO ADAPTER PLATE

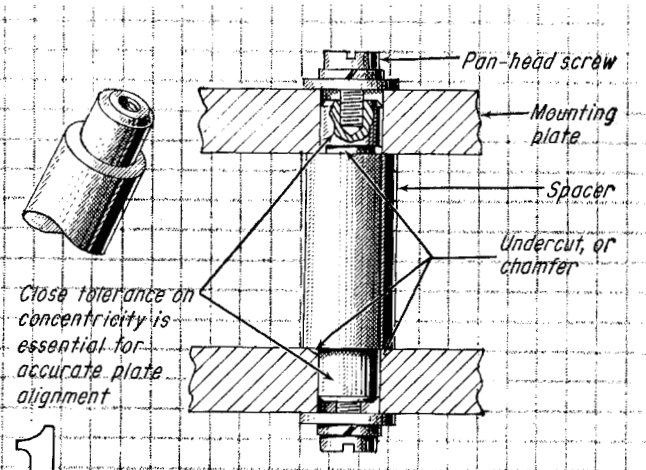


8 TWO HALF-RINGS AND RETAINING CAP

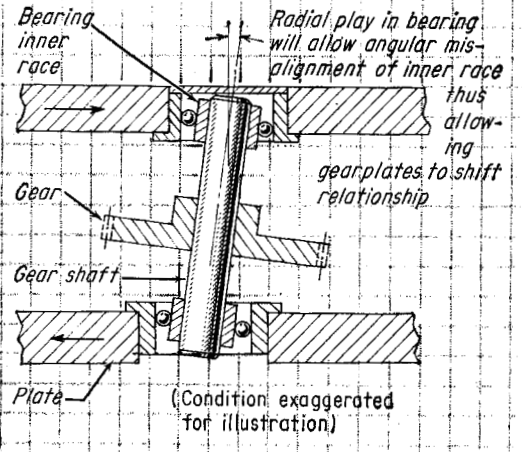
Fastening Precision Gear-Plates

Don't waste high-precision gears; design their mounts to provide accurate alignment even with unskilled assembly. Aim for rigidity too. Here are some "tricks of the trade."

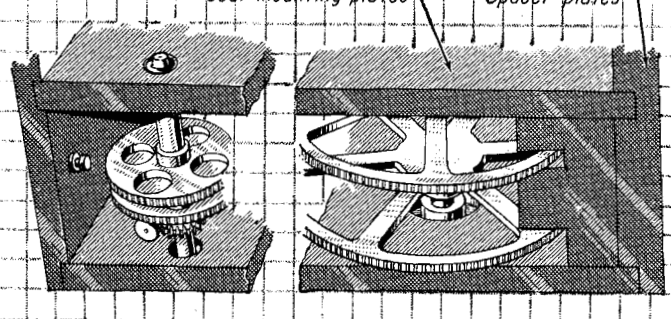
Frank William Wood JR



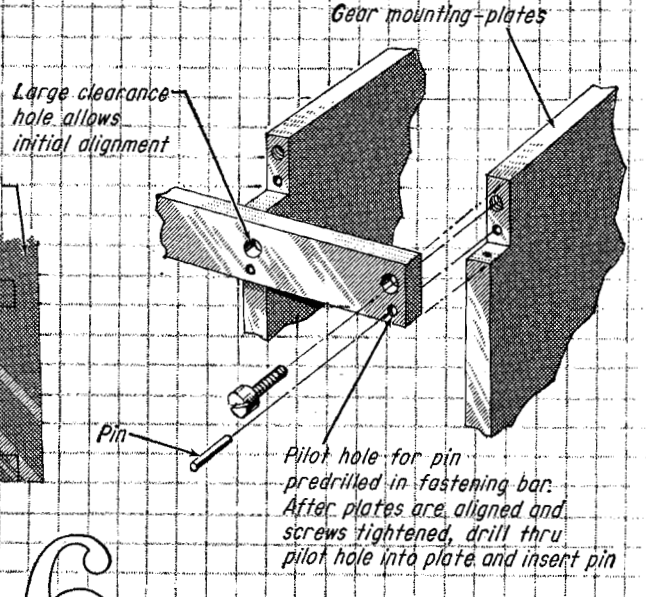
1 SHOULDERED SPACERS
are good when accurately made.


Bearing inner race
Radial play in bearing will allow angular misalignment of inner race thus allowing gearplates to shift relationship
Gear
Gear shaft
Plate
(Condition exaggerated for illustration)

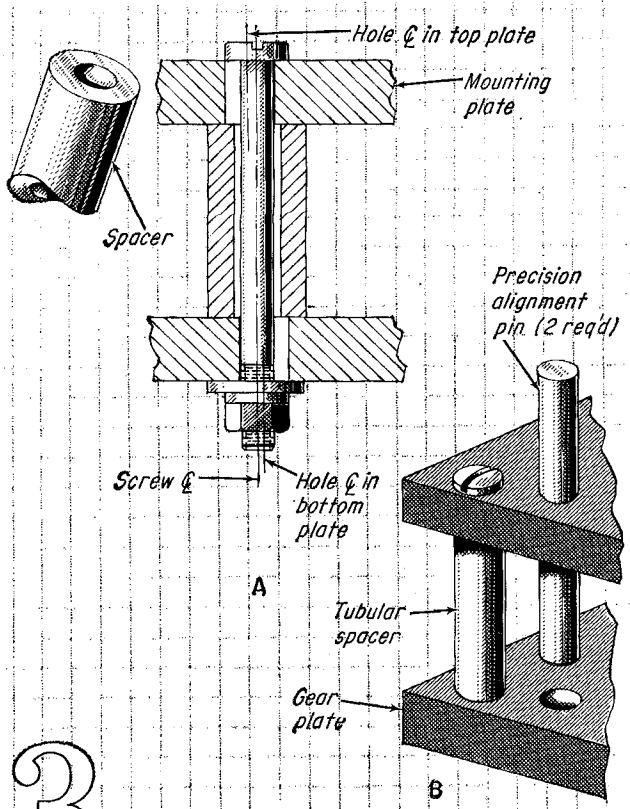
2 DON'T RELY
on shafts for alignment.



5 PLATES SUPPORTED AND REGISTERED
in grooves support heavy loads, but precision production requirements make method expensive.


Gear mounting plates
Large clearance hole allows initial alignment
Pin
Pilot hole for pin predrilled in fastening bar. After plates are aligned and screws tightened, drill thru pilot hole into plate and insert pin

6 ALIGNMENT PINS
ensure constant accuracy of alignment even after disassembly and re-assembly.



3 **TUBULAR SPACERS**
(with through bolt) need alignment pins.

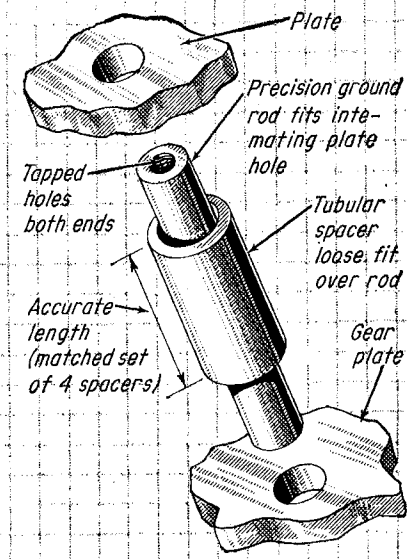
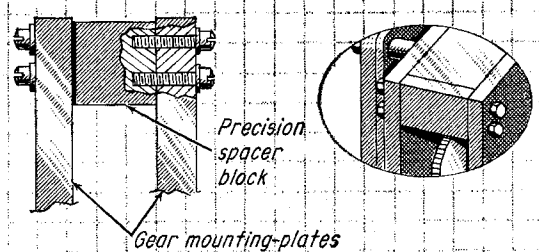
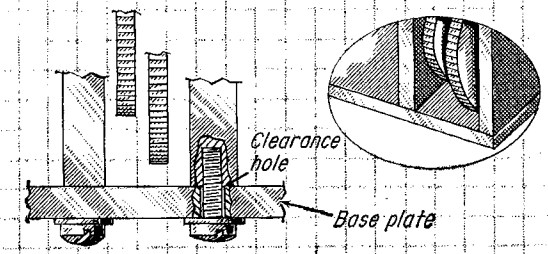


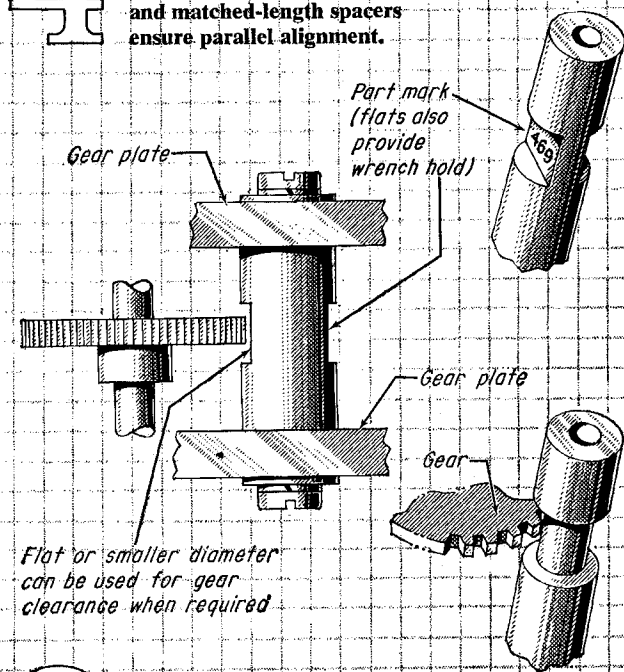
Plate
Precision ground rod fits intemating plate hole
Tapped holes both ends
Tubular spacer loose fit over rod
Accurate length (matched set of 4 spacers)
Gear plate

4 **PRECISION-GROUND ROD**
and matched-length spacers ensure parallel alignment.





7 **SPACER BLOCKS**
between mounting-plates make assembly tough to align. Base-plate removal also leaves mounting plates supported on one end only.

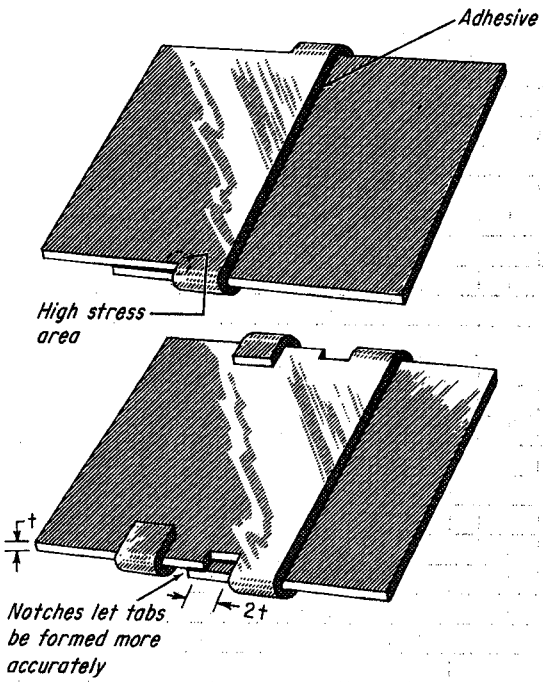

Part mark (flats also provide wrench hold)
469
Gear plate
Gear plate
Gear
Flat or smaller diameter can be used for gear clearance when required

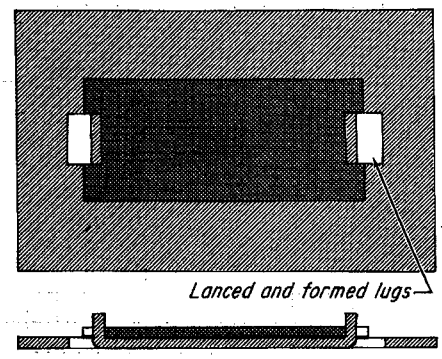
8 **AUXILIARY FEATURES**
on spacers increase cost but are sometimes necessary.

Bonding Sheet Metal with Adhesive

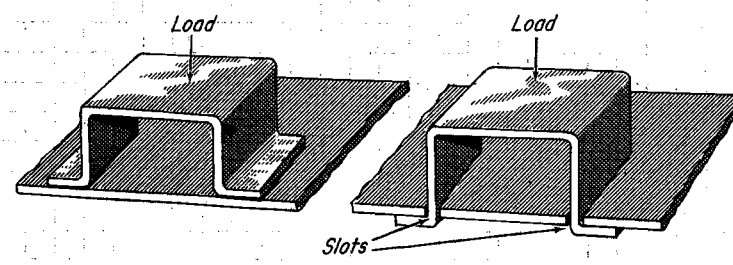
Tabs, lugs, rivets, folds, and other reinforcing methods should always accompany adhesive when the bonded parts are metal.

Federico Strasser

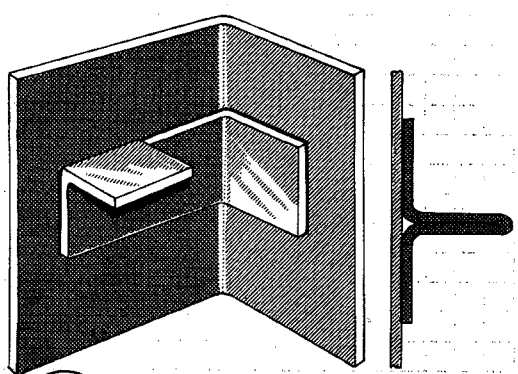




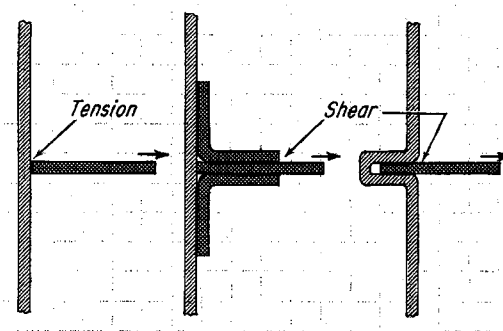
1 **TABS ADD PEEL STRENGTH.**



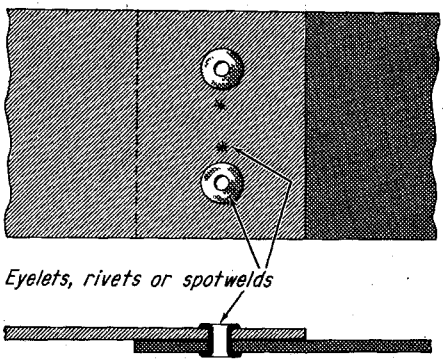
4 **SLOTS HERE ALLOW MAXIMUM JOINT STRENGTH.**



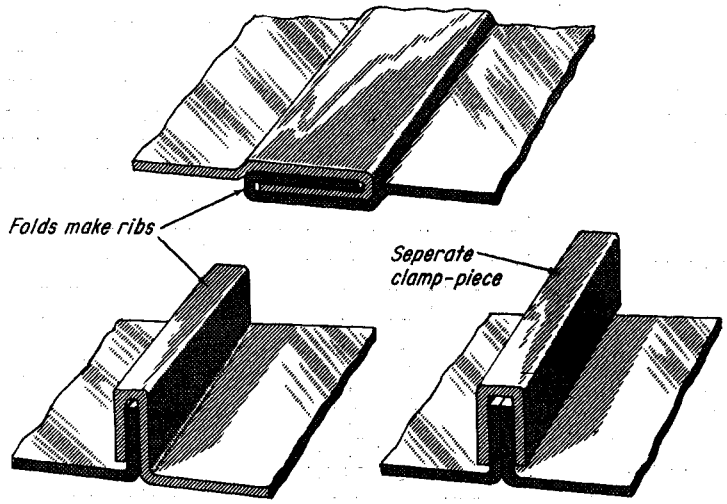
6 **INCREASED BOND AREA GIVES MORE SHEAR STRENGTH BUT NO MECHANICAL AID.**



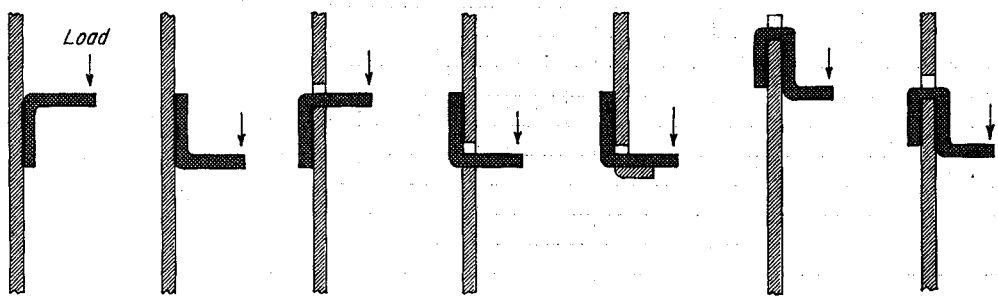
7 **ADHESIVE IS STRONGER IN SHEAR, PROVIDE FOR THIS IN DESIGN.**



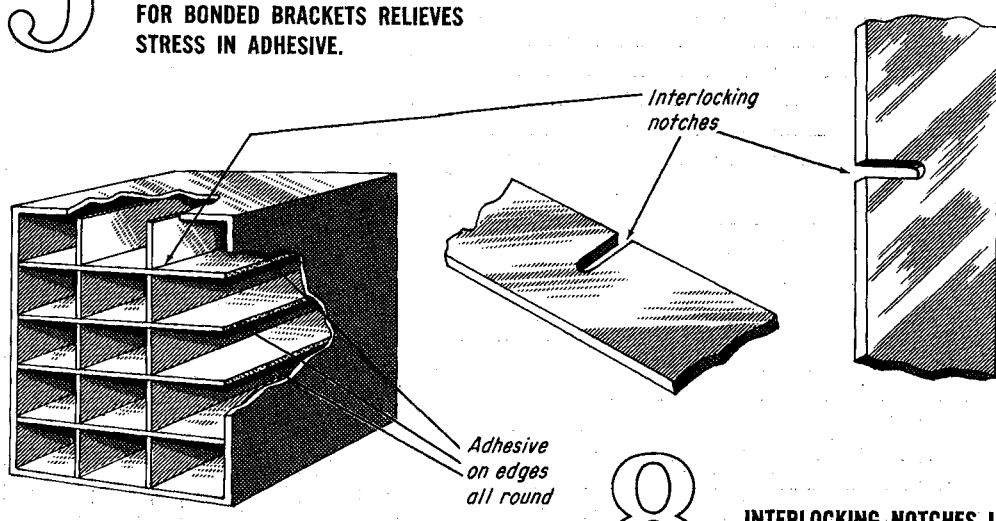
2 RIVETS OR SPOT WELDS ADD PEEL AND SHEAR STRENGTH.



3 FOLDS ARE SELF-CLAMPING; RIBS ADD RIGIDITY.



5 MECHANICAL SUPPORT FOR BONDED BRACKETS RELIEVES STRESS IN ADHESIVE.

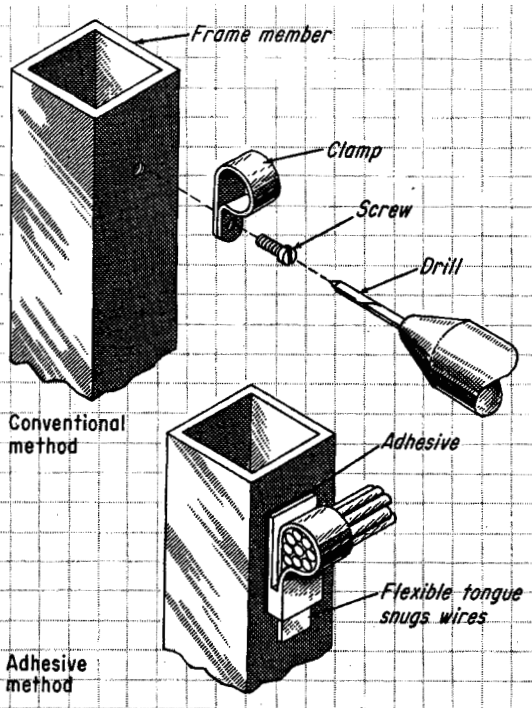


8 INTERLOCKING NOTCHES LET STRUCTURES SUPPORT THEMSELVES.

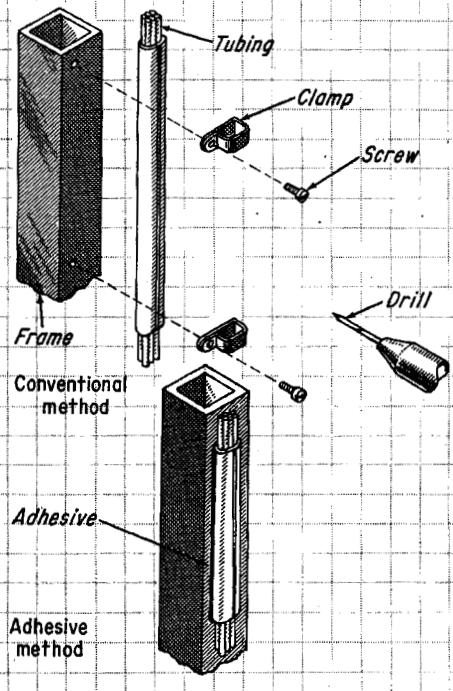
7 Ways to Assemble with Adhesives

Adhesives have come into their own now, so why not use them to greater advantage in mechanical and electrical assemblies?

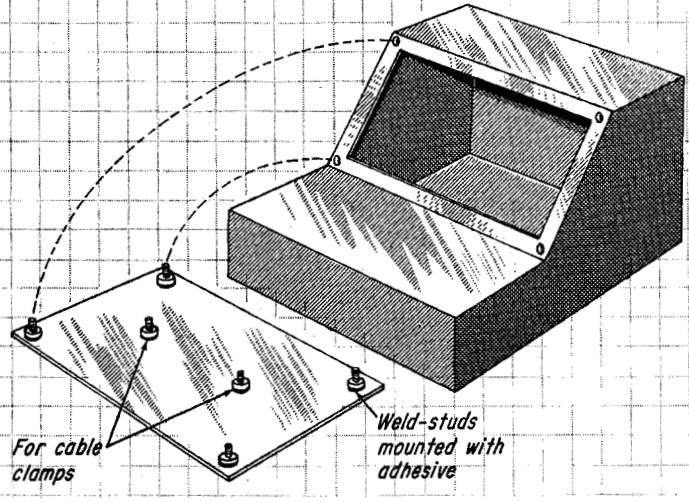
Eugene J. Amitrani



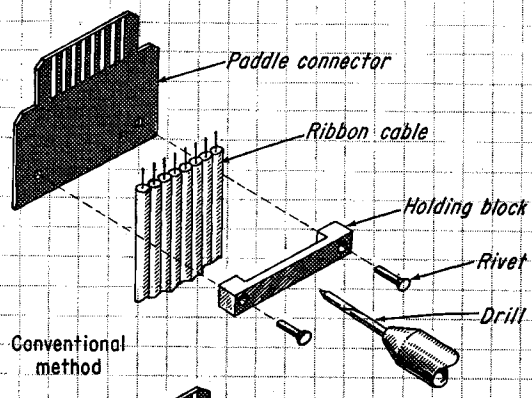
1 **CABLE CLAMP OF NEW DESIGN** uses adhesive as a fastening method. Conventional clamps can be fastened in the same manner.

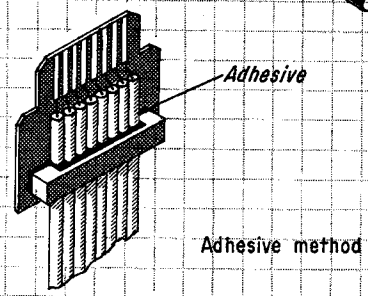


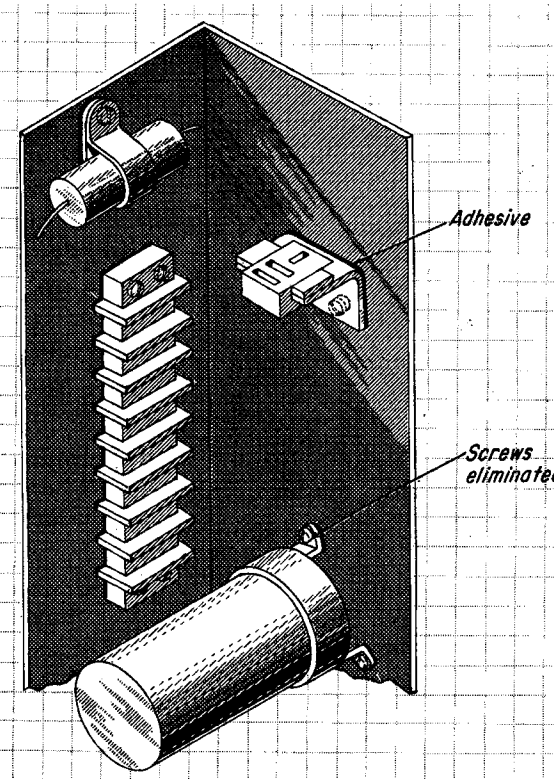
2 **TUBING ASSEMBLED TO FRAME** members does not require the use of screws and clamps when adhesive is used for the job.



5 **PANEL FINISH IS NOT MARRED** by using adhesive to mount studs. Welded studs spoil finish on panel outer surface.

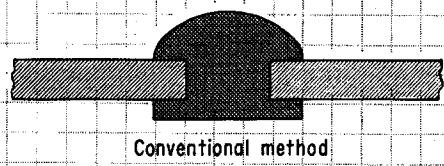


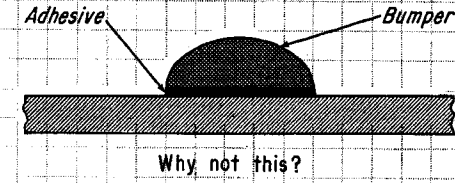




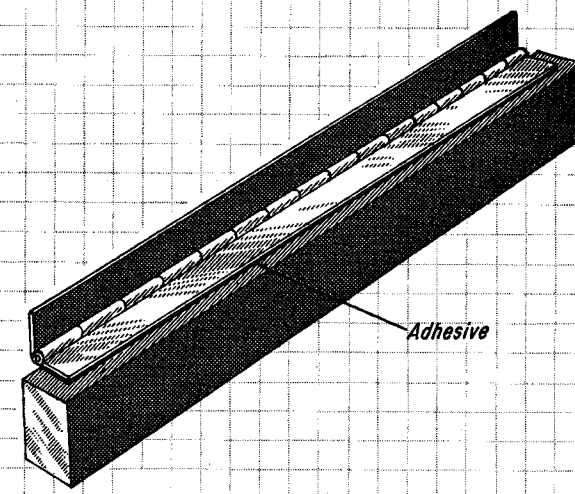
3 **SAVE RIVETS AND TIME** by using adhesive to fasten ribbon cable to connector-board. Dissassembly is not easy, though.

4 **SCREWS AND LOCKWASHERS** shown by dotted lines in sketch can be eliminated by using adhesive to attach components.





6 **RUBBER BUMPERS** usually need to be specially shaped and fitted into a hole in the component. Adhesive can simplify such assemblies.

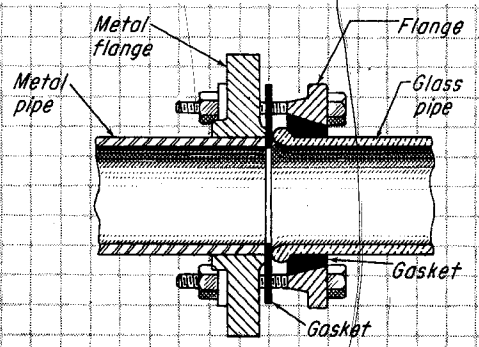


7 **PIANO HINGES** are frequently used in instrument cases. Adhesive saves both hardware and time spent in making sure alignment is accurate.

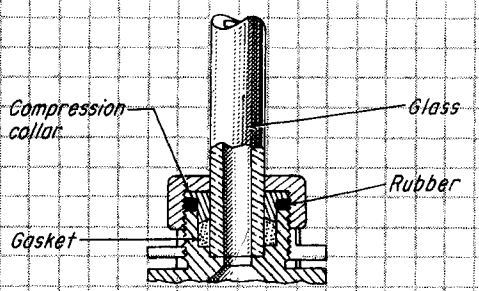
Glass-to-Metal Joints

Five ways of joining glass and metal to keep thermal stresses to safe levels.

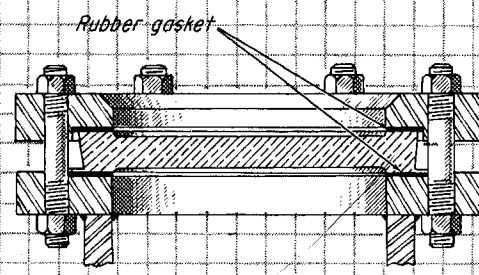
Robert H. Dalton



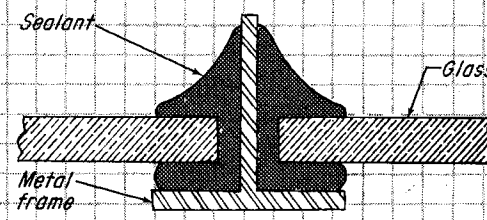
1 Glass pipe joined to metal flange; gaskets distribute clamping stresses



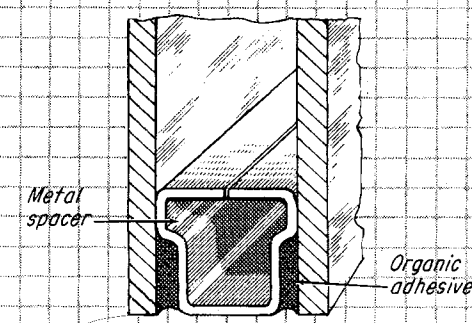
2 Clamp for gage glass for low-pressure boiler permits axial movement



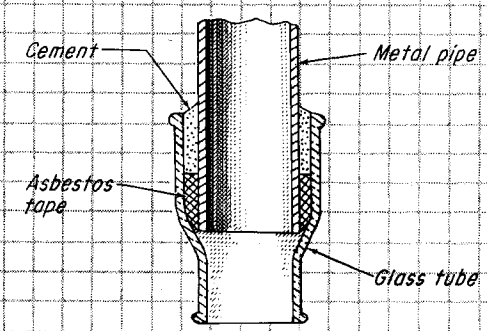
3 Window for high-pressure service requires flexible gaskets



4 Flexible sealant retains glass to metal frame under light loads

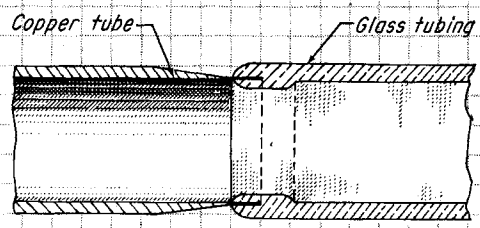


5 Double-glazed window bonded to metal spacer forms rigid structure

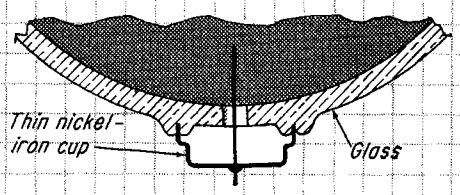


6 Cement combined with asbestos tape joins glass and metal pipe

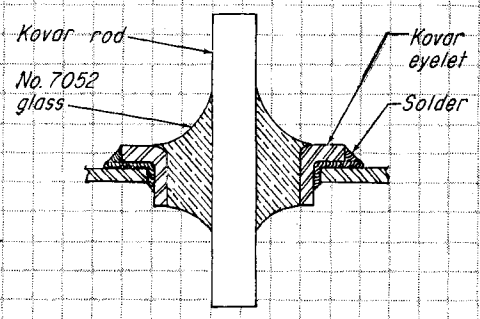
Fused glass



7 Housekeeper seal uses thin wedge of metal to minimize stresses at joint

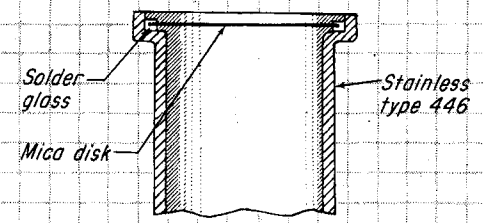


8 Saled-beam lamp has thin flexible metal cap fused to glass



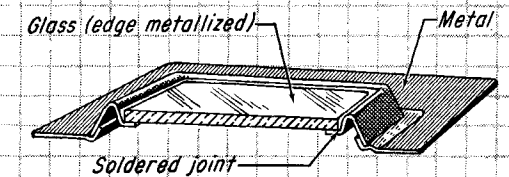
9 Hermetic seal matches expansion rate of rod and glass to reduce stress

Solder glass

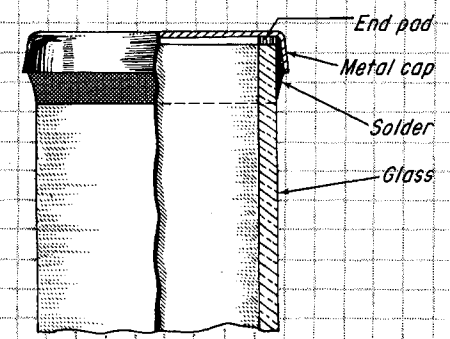


10 Low-melting solder glass minimizes heat damage to mating parts

Metallized glass



11 Metallized edge of glass window is soldered to flexible metal frame



12 Thin metal cap soldered to large-area metallized glass surface

Simplifying Assemblies with Spring-Steel Fasteners

Since annealed spring steel can be stamped, twisted, or bent into any desirable shape and then heat-treated to develop spring characteristics, it can be designed for multiple functions in addition to that of fastening. Shown below are 16 ways in which spring-steel fasteners can be used to. . . . .

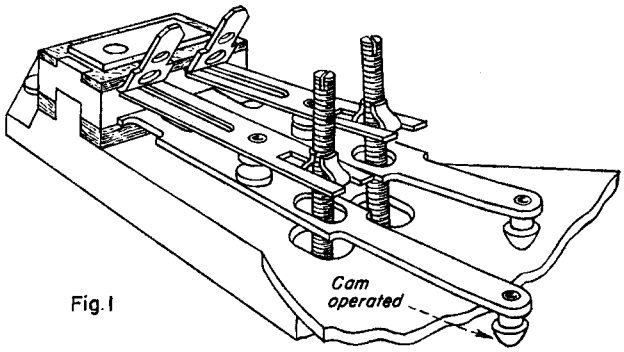


Fig. 1

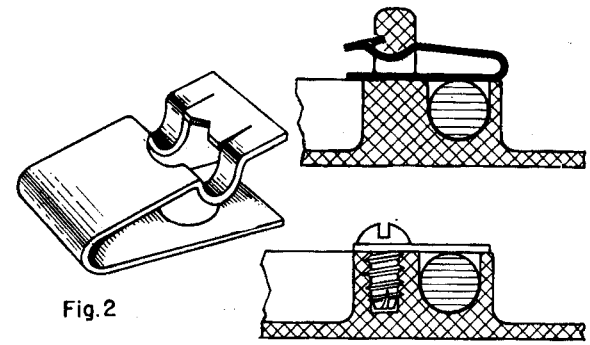
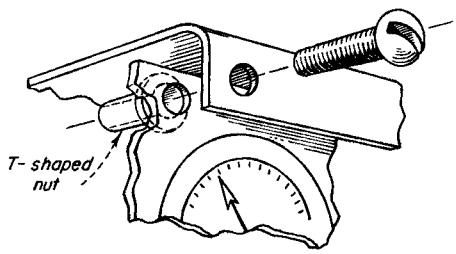


Fig. 2



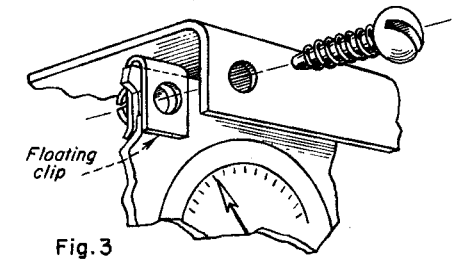


Fig. 3

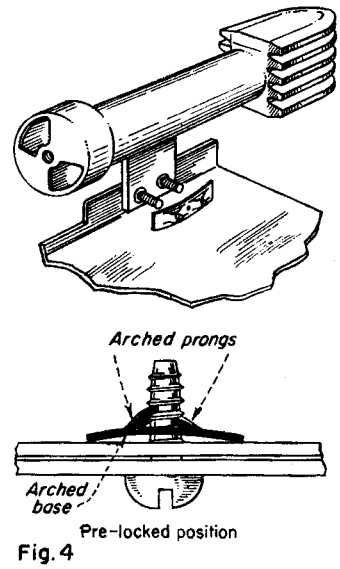


Fig. 4

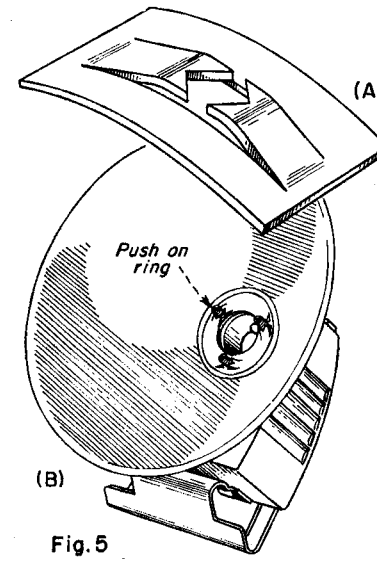


Fig. 5

FIG. 1—Multiple-purpose flat spring has stamped hole helically formed to accept adjusting screw. Replaces a locknut, bushing with internal threads and spring blade. Screw adjusts gap of contacts thus changing duration of current flow. Application: thermostatic timing control unit of an automatic beverage percolator.

FIG. 2—Spring-steel clip firmly holds stud of control knob while allowing it to turn freely on its bearing surface. Clip is removed by merely compressing spring arms and pulling off stud. Replaces screw and machined plate.

FIG. 3—Floating clip, which snaps in place by hand, reduces hole misalignment problems by permitting sufficient shift of mounting holes to offset normal manufacturing tolerances of main parts. Replaces welded T-shape nuts.

FIG. 4—Twin-hole nut removes need for hand wrench in hard-to-reach location and replaces two nuts and lockwashers. Combined force of arched prongs and base when nut is compressed creates high resistance to vibration loosening. Application: gas burner assembly of an automatic household clothes dryer heating unit.

FIG. 5—Push-on nuts (A) easily press over studs, rivets, tubing and other unthreaded parts. Their steel prongs securely bite into smooth surfaces under load. Application: (B) triple-hole push-on ring on a flash bulb reflector.

FIG. 6—Previous method of assembling desk calendar (A) required seven parts: wire guide, spring clip, plate, two bolts and two nuts. Multi-purpose spring clip (B) replaces above although using same retaining principle.

compensate for hole or part misalignment; prevent vibration loosening; eliminate parts; speed assembly; permit fastener removals; lock on unthreaded studs; and permit blind installations.

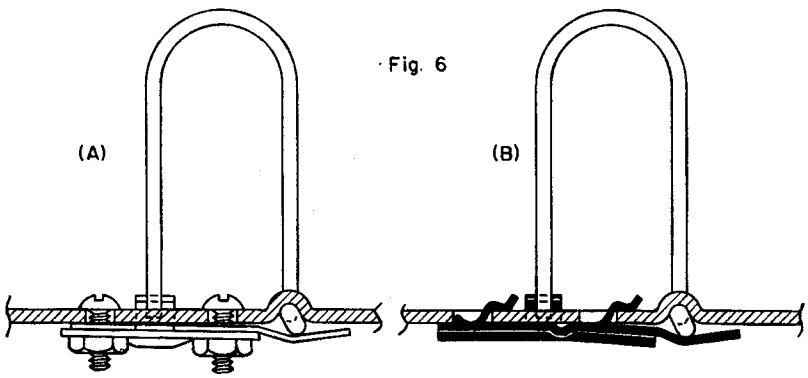


Fig. 6

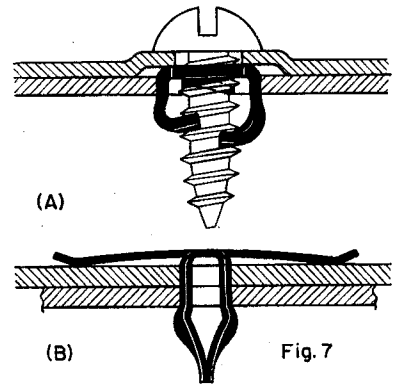


Fig. 7

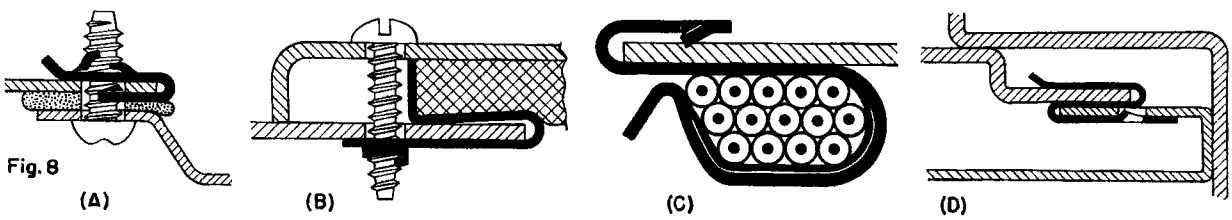


Fig. 8

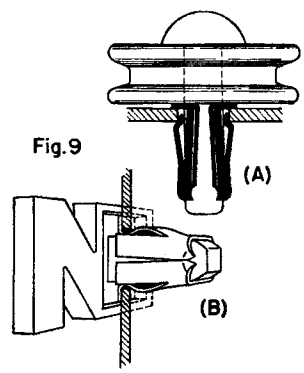


Fig. 9

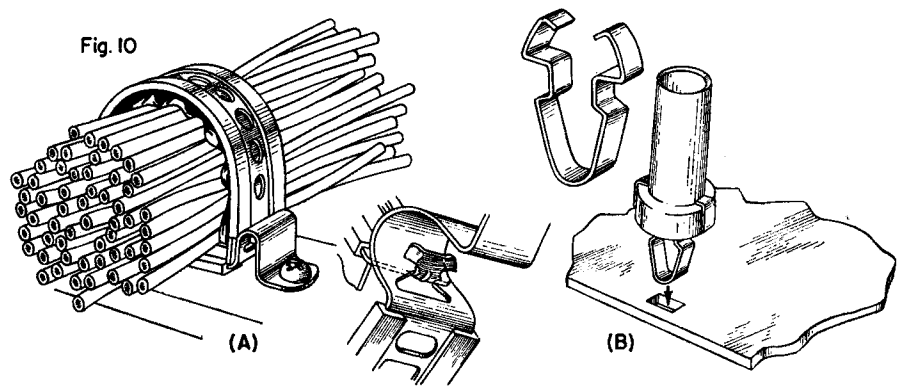


Fig. 10

FIG. 7—Expansion-type fastener permits blind installation where access is from one side of an assembly only. Insertion of screw (A) spreads fastener arms apart thus producing a wedging effect in the hole. Dart-type fastener (B) can be quickly snapped in place; one common application is attaching molding trim strips to auto panels.

FIG. 8—End clips pressed by hand on panel edges have barbed retaining leg which either bites into the metal or snaps into a mounting hole. Applications: (A) sheet metal screw and J-clip with arched prongs compresses insulating material between panels; (B) bent leg of clip acts as spacer between two panels to support sheet of insulating material; (C) barbed-leg-clip retains wires without need for mounting hole; (D) S-clip spring-steel fastener secures removable panel in inaccessible position.

FIG. 9—Tubular-type fastener has cam-like prongs which spring out after insertion to hold fastener in position. Applications: (A) radio dial pulley; (B) attaching automotive name plate to panel.

FIG. 10—Special-function fasteners for quick assembly and disassembly of components. (A) Wire harness clamp using torque and slot principle; (B) dart-shaped clip for attaching coils and other parts to electronic chassis.

Spring-Steel Fasteners

This is the first of a series of articles on special fasteners. Future articles will cover cold-formed and quick-operating fasteners, plus new fastening ideas.

Ted Black

Spring-steel fasteners are versatile and low in cost. The steel is bent, twisted, and pierced, sheared and drawn into almost any desired shape to form a one-piece fastener that combines the functions of several ordinary fastening components, reducing fastening costs.

Spring clips are a major class of spring-steel fasteners and are particularly useful as light-duty fasteners. They are self-retaining units, needing only a hole, flange or panel edge to clip to. Their inherent springiness makes them resistant to loosening by vibration, and tolerant of tolerance buildup and misalignment.

The field of application of spring clips is a broad one, including automobiles, home appliances, hi-fi and electronic equipment, toys, aircraft and office equipment.

Dart type spring clips (Fig 1) have hips that engage within a hole to fasten two sheets or panels. Dart clips are popular for fastening printed-circuit boards and nameplates. Other shapes fasten cables, tubes and wires.

An advantage of dart clips is easy removability; therefore, minimum disassembly damage. Their retention power can be varied by changing the length and thickness of the clip legs.

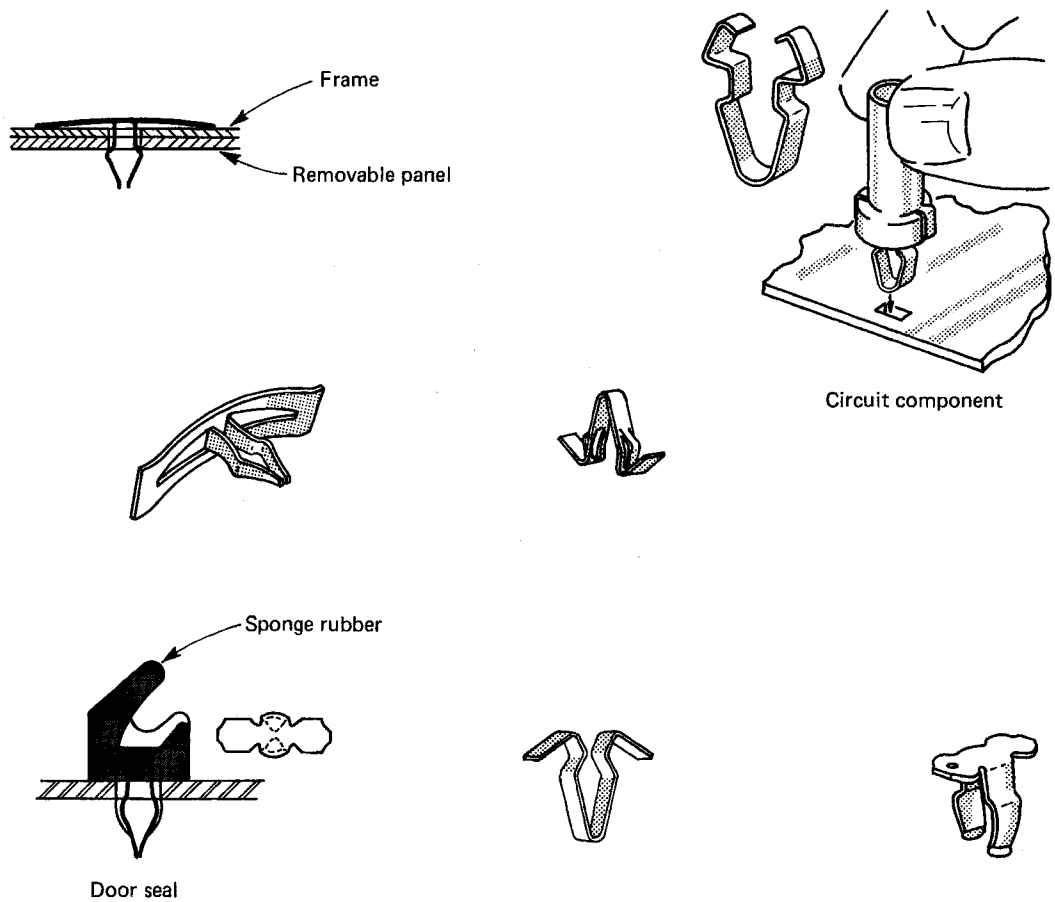
Stud-gripper spring clips (Fig 2) are designed to grip unthreaded studs, pins, rivets and tubes. The studs can be of circular cross section, as is usually the case, or of square or D cross section.

Generally, the stud gripper has two or more prongs that permit the clip to be forced down on a stud. Such grippers resist removal. Any back pressure against the clip causes the prong to bite deeper into the stud.

Some stud grippers use a split tubular sleeve to grip the unthreaded stud or rivet. Such clips provide a secure lock, yet allow panels to be separated for service.

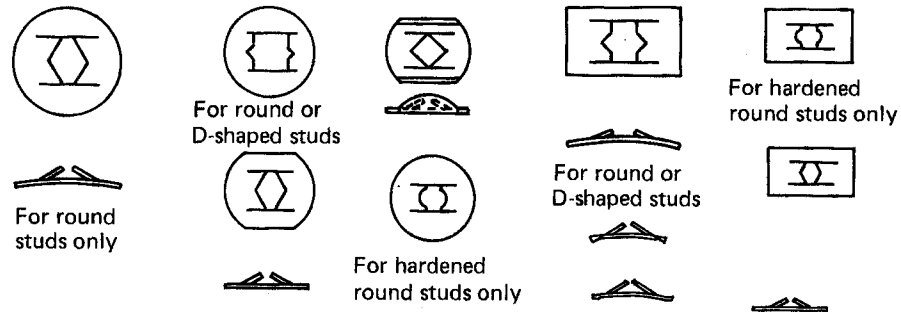
Cap push-on stud grippers are used on

1. Dart clips

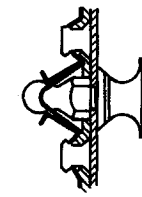


2. Stud grippers

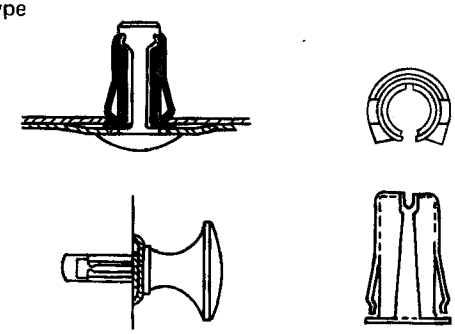
Push-on type



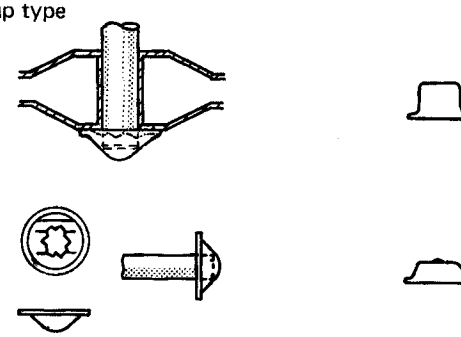
Ball-stud type



Tubular type

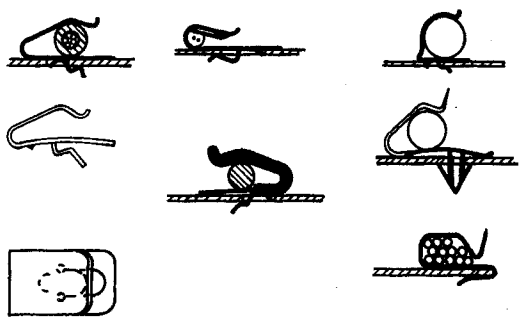


Cap type

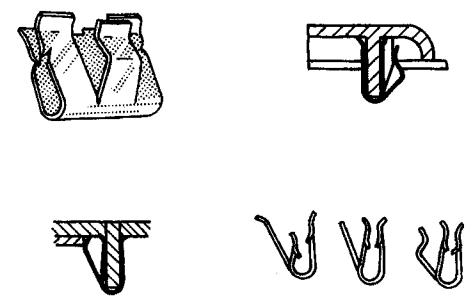


3. Cable, wire and tube clips

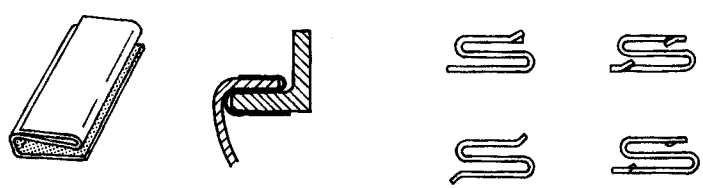
Cable clips



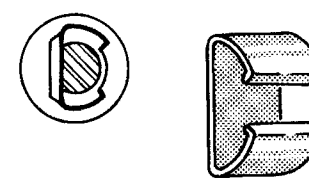
U-clips



S-clips



D-clips



axles, shafts or rods, or as stud-end covers. Quickly installed, they eliminate the need for special machining or threading operations or cotter keys.

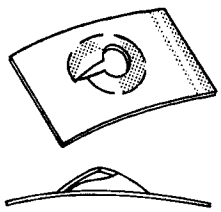
Wire and tube clips (Fig 3) are designed to grip into a hole or plate, or retain a wire or tube. They can be employed on existing parts and assemblies without a design change.

U-shape clips are used for assembling cover panels or as inexpensive hinge retainers. S-shape clips can clamp onto a part while clamping a panel or a flange of a component. C-shape clips provide a compression action that can hold plastic knobs firmly to steel shafts and permit them to be easily removed.

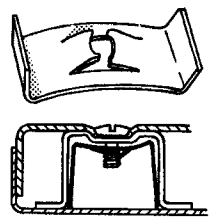
Spring-steel nuts (Fig 4) are single-thread engaging locknuts stamped into various convenient shapes. Available designs include flat, arched-back nuts; W-shape nuts with turned-up ends; self-retained, self-locking nuts; single-thread nuts for use in cavities; high-torque nuts with out-of-phase threads to increase vibration resistance; and nuts that cut their own threads into diecast metal or molded plastic studs.

Some spring-steel locknuts have threads in which the thread-engaging portion is helically formed in true relation to the pitch of the screw thread. These nuts have straight sides and hexagonal shapes for easy handling and positive rundown. Also useful are spring nuts designed to retain a shiftable nut to provide rivetless retention of nuts on plates (Fig 5).

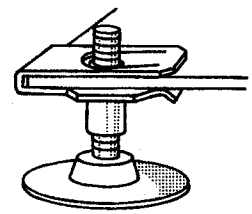
4. Spring-steel nuts



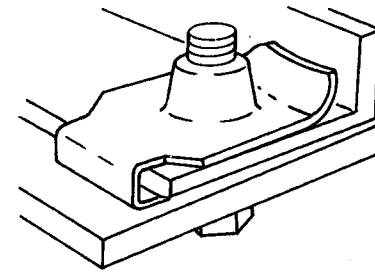
Flat nut



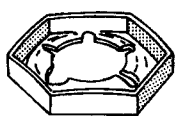
W-nut



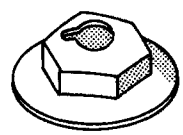
Leg-leveling U-nut



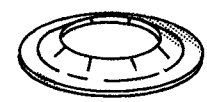
Short-throat U-nut



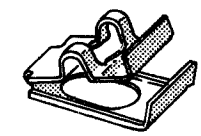
Regular locknut



Washer locknut

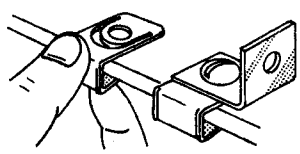


Flat round pushnut

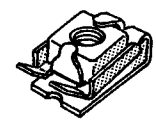


Removable pushnut

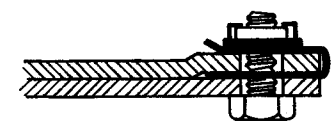
5. Clip-on nuts and nut retainers



Clip-on nut



Clip-on nut retainer

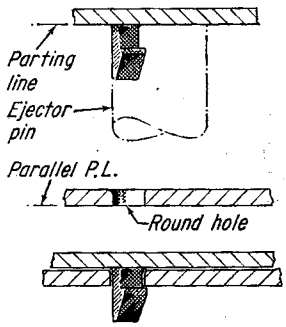


Clip-on nut retainer

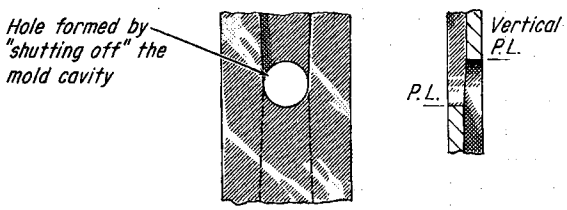
Snap Fasteners for Polyethylene Parts

It's difficult to cement polyethylene parts together, so eliminate extra cost of separate fasteners with these snap-together designs.

Edger Burns

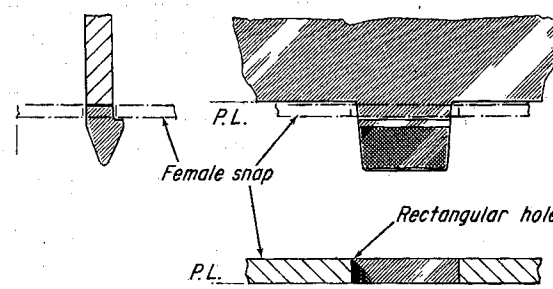


(a) Cored hole

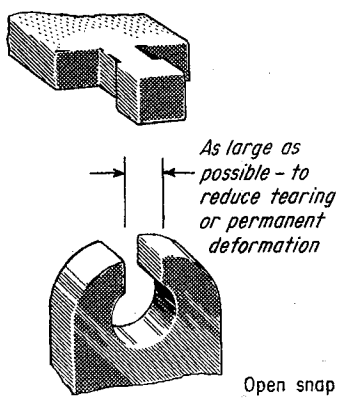


(b) "Shut-off" hole for female snap for different P.L.

1 **EJECTOR-PIN** of mold is cut to shape of snap. Ejected with the pin, the part is slid off the pin by the operator.

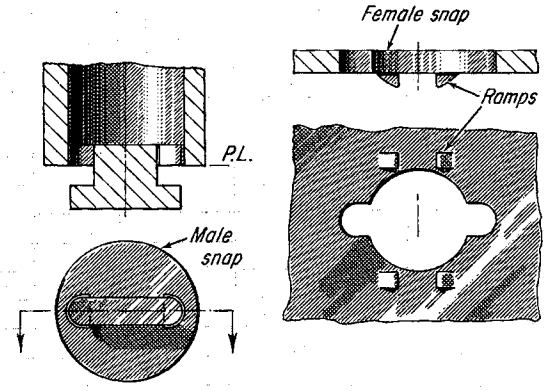


2 **WALL-END SNAP** is easier to remove from the mold than the ejector-pin snap. The best length for this snap is ¼ to ½ in.



Open snap

3 **OPEN SNAP** relies on an undercut in the mold and on the ability of the polyethylene to deform and then spring back on ejection.



4 **T SNAP** locks with a 90-deg turn. To prevent this snap from working loose, four small ramps are added to the female part.

Plastic Snap-Fit Design Interlocks in Unique and Useful Ways

Snap-on caps and latches are deceptively simple, but were evolved using good engineering design. Here's a recent study.

In response to the often-heard suggestion that snap fits are not dependable because they have a tendency to pop out, Dr. William W. Chow of the University of Illinois in Urbana has developed (and presented in an ASME paper) an analytic method for predicting snap-in and snap-out forces. His conclusion is that a well-designed snap fit cannot be easily pulled out, and has certain advantages over other methods.

For example, a screw fit can vibrate loose, a press fit depends on friction and strain to hold, and a sonic weld is permanent.

The snap fit is a simple mechanical interlock whose pull-out force can be hundreds of times larger than the push-in force. It takes careful selection of the slope of the bevel on both the entering lip and the withdrawal lip. The extreme is a cap or latch that snaps on easily, but locks on permanently—like a fish hook.

We asked Chow how he solved the design problems. He said he first examined the simplest case of a cantilever-type snap with zero friction. Next, the same snap was analyzed with the effect of friction. The results then were generalized to cover all kinds of snaps.

The calculation. Assuming zero friction (μ=zero) the snap-in force is related to the spring rate of the snap by the tangent of the lead angles and the interference (see accompanying cantilever drawing as an example).

With zero friction, snap-in force $F_i = F_s \tan\alpha$, or $K\ i \tan\alpha$. Snap-out force $F_o = F_s \tan\beta$, or $K\ i \tan\beta$, where:

- μ = coefficient of friction
- F_s = snap force, the force that reduces i to zero
- i = interference
- K = spring rate of the snap
- α = lead angle
- β = return angle

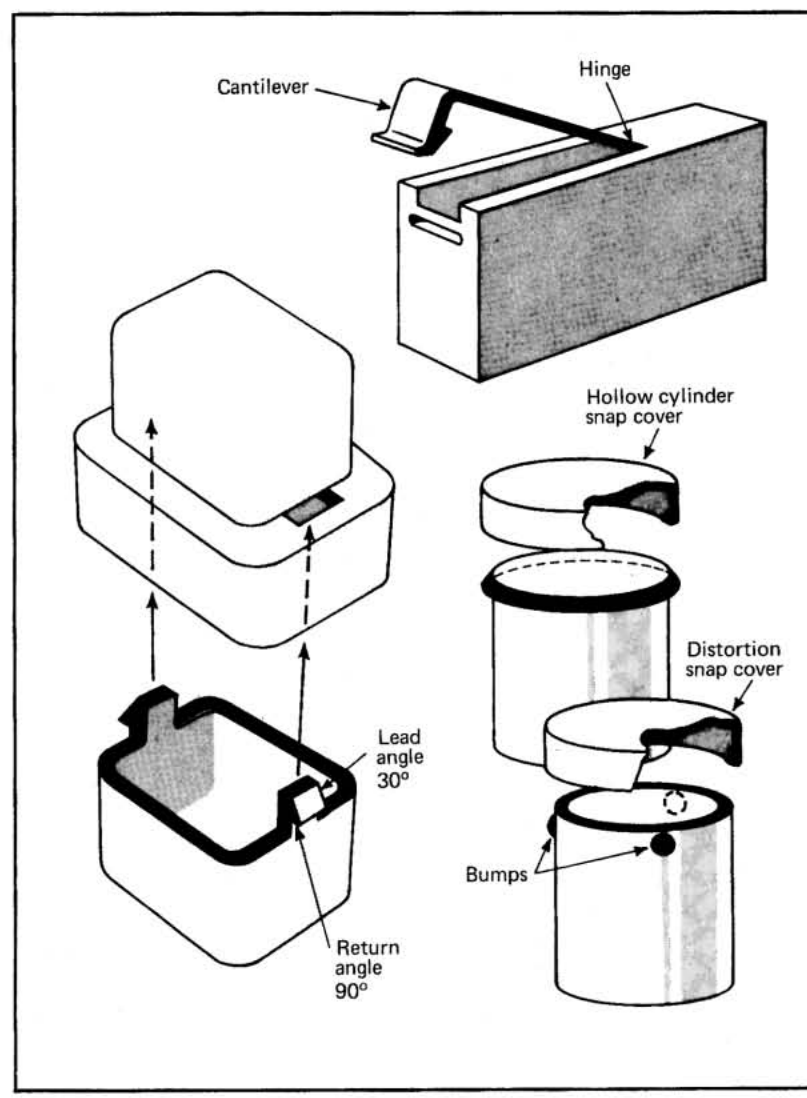
The smaller the lead angle, the easier it is to assemble the snap. The smaller the return angle, the less force is needed to disassemble the snap. When the return angle is 90 deg, the snap is self-locking. When the return angle is greater than 90 deg, the interference is a barb.

With friction, the tangent term becomes a more complex function of the lead angle, α, and the coefficient of friction, μ:

$$\text{Force } F_i = F_s \frac{(\sin\alpha + \mu\cos\alpha)}{(\cos\alpha - \mu\sin\alpha)}$$

$$\text{Force } F_o = F_s \frac{(\sin\beta + \mu\cos\beta)}{(\cos\beta - \mu\sin\beta)}$$

The analysis also applies to hollow cylinder snaps and distortion snaps, but the spring rate has to be figured accordingly. Spring rate of a snap is defined as the snap force, F_s, that is required to reduce the interference to zero, divided by the interference. The spring rate for a hollow cylinder snap, K_{cyl}, is the total force in the radial direction, F_r, divided by the increase in radius, i_{rad}.



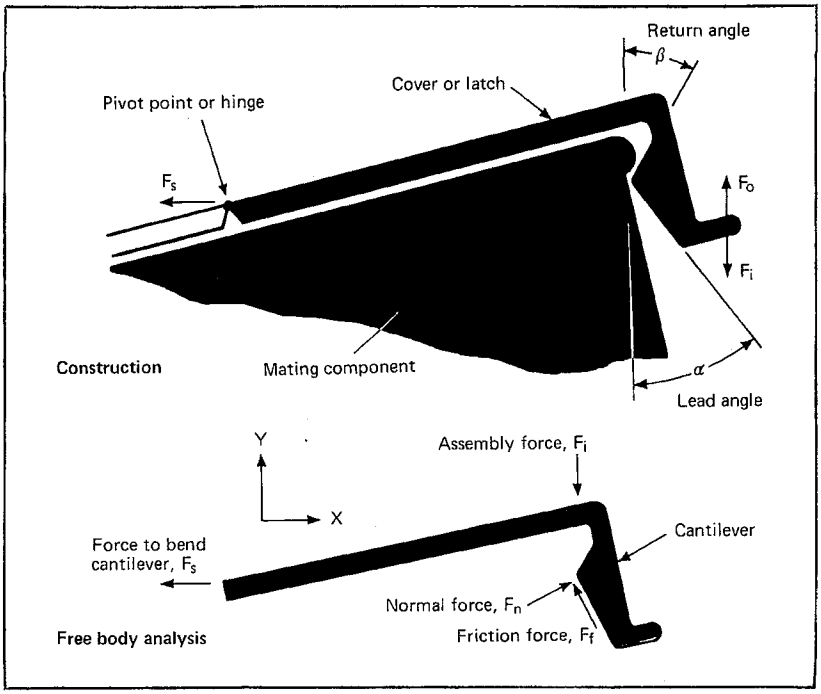
These snap-fit designs are typical of what can be done using the accompanying calculation techniques. The example worked out is for simple cantilever

$$K_{cyl} = \frac{F_r}{i_{rad}}$$

Snap-in snap-out forces. The next drawing shows examples of cylindrical snaps. The distortion-type lid is a variation of the hollow cylinder snap, and mates with a smaller cylinder with three bumps. The spring rate, K_{dist} is three times the force at each bump, F_b, divided by the interference at the bump, i_{bump}:

$$K_{dist} = \frac{3F_b}{i_{bump}}$$

The product of K and i gives the snap force, and the product of the snap force and the tangent of the lead angles gives the snap-in and snap-out forces.



Cantilever design with hinge is simplest configuration for mathematical analysis

Basic stress-strain equations for snap-fit elements

	Spring rate, K	Stress, σ	Strain, ϵ	Allowed interference, i
Fixed end, Fs, b, t, L — Uniform cantilever	$\frac{Eb}{4}\left(\frac{t}{L}\right)^3$	$\frac{3Eit}{2L^2}$	$\frac{3it}{2L^2}$	$\frac{2S_yL^2}{3Et}$
Fs, b, L, t — Tapered cantilever	$\frac{Eb}{6}\left(\frac{t}{L}\right)^3$	$\frac{Eit}{L^2}$	$\frac{it}{L^2}$	$\frac{S_yL^2}{Et}$
t, r, b — Thin-wall cylinder	$2\pi Eb\left(\frac{t}{r}\right)$	$\left(\frac{i}{r}\right)E$	$\frac{i}{r}$	$\frac{S_yr}{E}$

Typical snap-in and snap-out forces are in the range of 2.5 to 250 Newtons (about 0.50 to 55 lb). Interferences are usually between 0.25 to 2.5 mm (about 0.010 to 0.100 in.). If: the coefficient of friction is 0.15; the lead angle is 30 deg; the interference is 1 mm; and the spring rate is 5000 N/m; then the equation shows that snap-in force is 3.98 Newtons.

The table lists some approximate spring rates for three simplified spring geometries: a uniform cantilever; a tapered cantilever; and a thin-walled hollow cylinder.

Referring to the free body drawing of the cantilever: force acting at the interference consists of a normal component, F_n, and a tangent component, F_f(friction). Since all the forces meet at one point, the summation of moments and forces equals zero: $M = 0$; and $F = F_n + F_s + F_n + F_f = 0$.

F_i = snap-in force
F_s = snap force, the force needed to reduce interference to zero
F_n = normal force at the interference
F_f = friction force at the interference $= \mu F_n$

Consider the x-component:

$$F_n \cos \alpha - F_f \sin\alpha - F_s = 0$$

$$F_n = \frac{F_s}{\cos \alpha - \mu \sin \alpha}$$

Consider the y-component:

$$F_n \sin \alpha + F_i = 0$$

$$F_i = F_n (\sin \alpha + \mu \cos \alpha)$$

Combine the x and y, and we're back to:

$$F_i = F_s \frac{(\sin \alpha + \mu \cos \alpha)}{(\cos \alpha - \mu \sin \alpha)}$$

$$F_o = F_s \frac{(\sin \beta + \mu \cos \beta)}{(\cos \beta - \mu \sin \beta)}$$

And, if friction is considered negligible, $F_i = F_s \tan \alpha$; and $F_o = F_s \tan \beta$.

Widely applicable. Snap fits for plastic are common in closures for fill pipes, bottles, container walls, and other applications where positive closure is needed but tools aren't readily available.

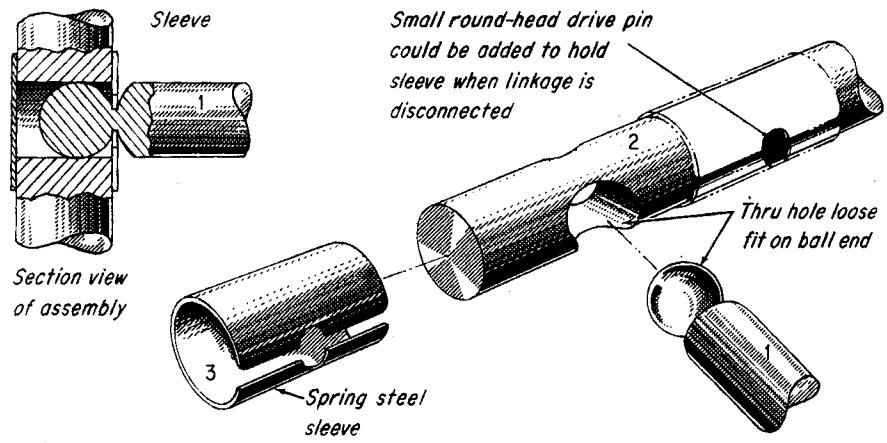
Cap and plug manufacturers such as Caplugs/Protective Closures (Buffalo, N.Y.), Niagara Plastics (Erie, Pa.), Clover (Tonawanda, N.Y.), Sinclair & Rush (St. Louis, Mo.), and Heyco (Kenilworth, NJ), employ the principles in many products they offer.

Caplugs, for example, features internal beads in certain of its cap closures, so that they snap into place and hold against vibration. Jim Rooney, president of Niagara Plastics, points out that a popular material is low-density polyethylene.

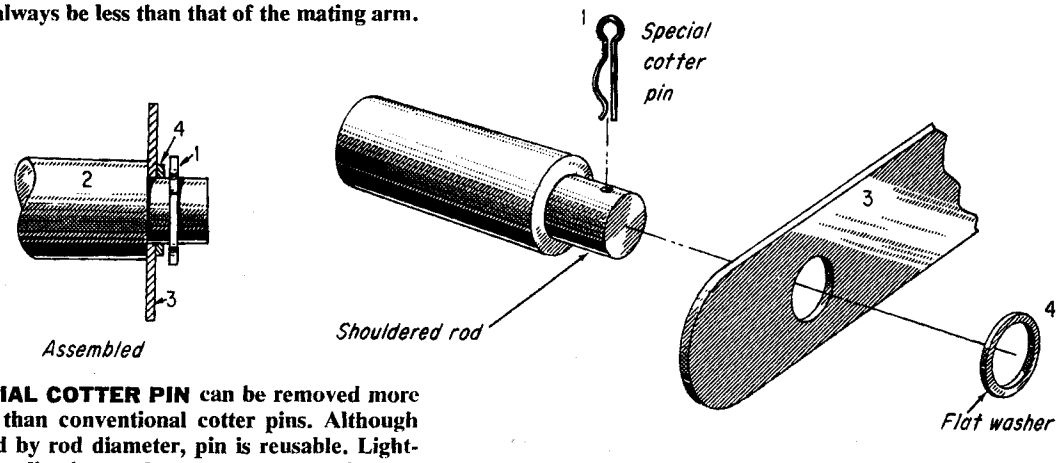
Fasteners that Disconnect Quickly

Ideal for linkages, these quick-disconnect designs can simplify installation and maintenance because no tools are needed.

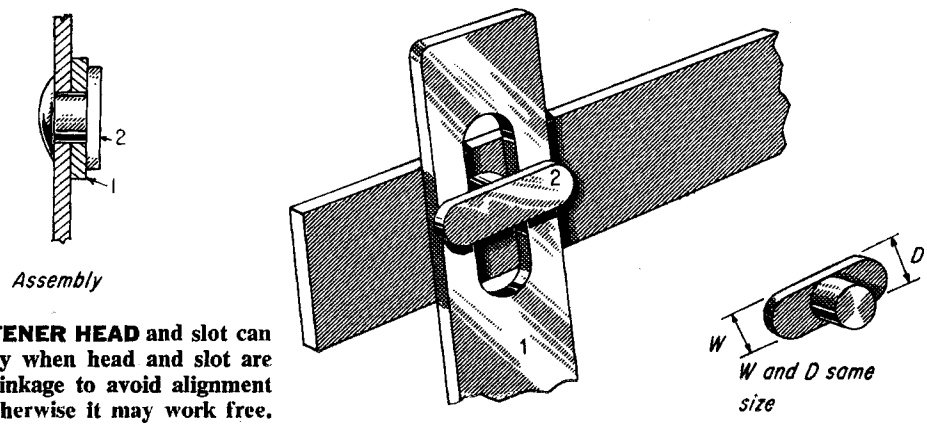
Frank W. Wood JR.


Sleeve
1
Section view of assembly
Small round-head drive pin could be added to hold sleeve when linkage is disconnected
2
Thru hole loose fit on ball end
3
Spring steel sleeve

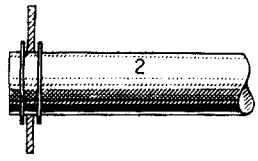
1 **BALL JOINT** and spring sleeve provide snug universal motion when hole in center of sleeve snaps over base diameter of ball. Ball diameter must always be less than that of the mating arm.



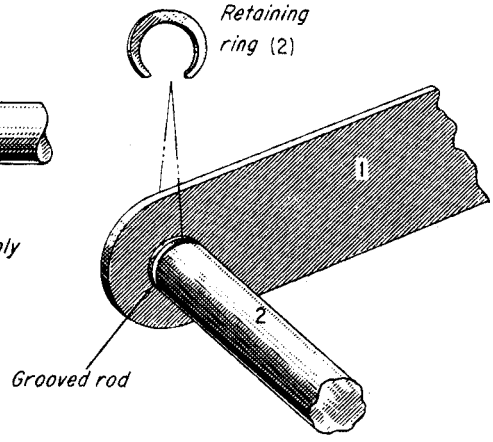
3 **SPECIAL COTTER PIN** can be removed more easily than conventional cotter pins. Although limited by rod diameter, pin is reusable. Light-duty applications only are recommended.

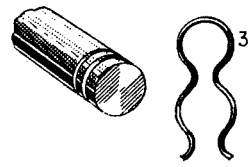


5 **ELONGATED FASTENER HEAD** and slot can be disconnected only when head and slot are aligned. Phase the linkage to avoid alignment of slot and head; otherwise it may work free.



Section thru assembly

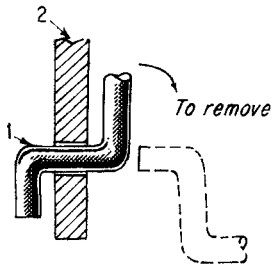


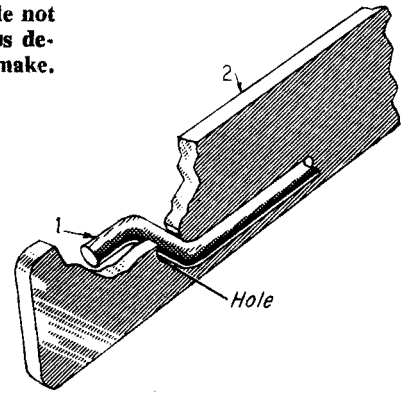


Formed wire retainer is easier to remove

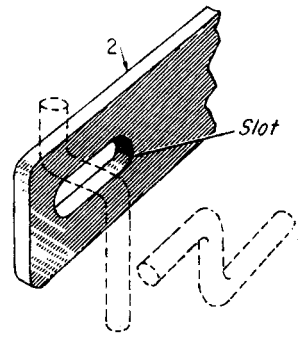
2

GROOVED ROD and retaining rings, while not having the freedom of motion of previous design, are simple and inexpensive to make. Double grooves are usually necessary.





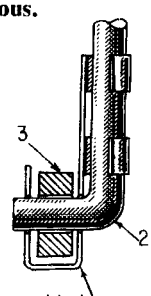
(A)

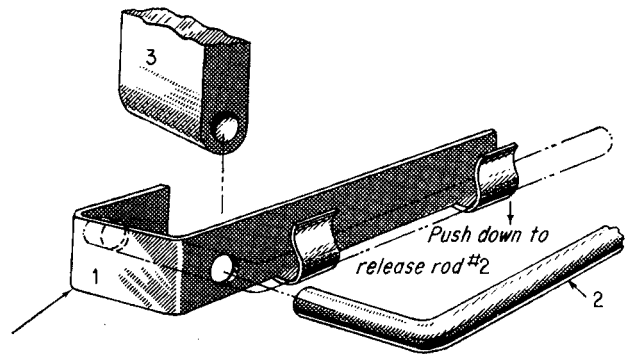


(B)

4

FORMED ROD in hole or slot allows disassembly only when the rod is free to be manipulated out of the arm. Slot design has play, which may or may not be advantageous.





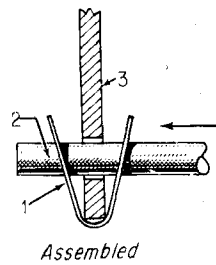
6

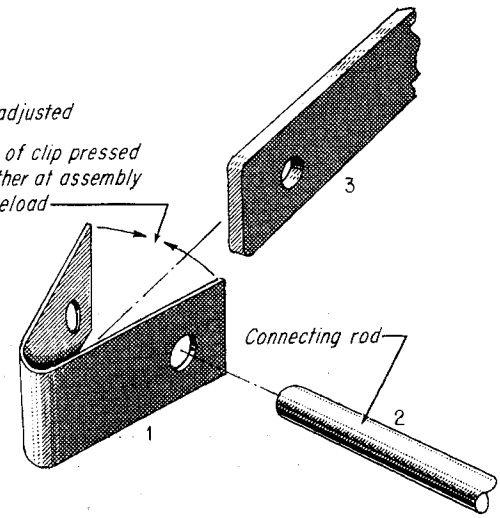
RETAINER CLIP and formed rod are ideal when production quantities are high enough to warrant tooling costs necessary for clip. But the clip is relatively easy to make.

More Quick-Disconnect Linkages

These methods of fastening linkage arms allow them to be disassembled without tools. Snap slides, springs, pins, etc, are featured.

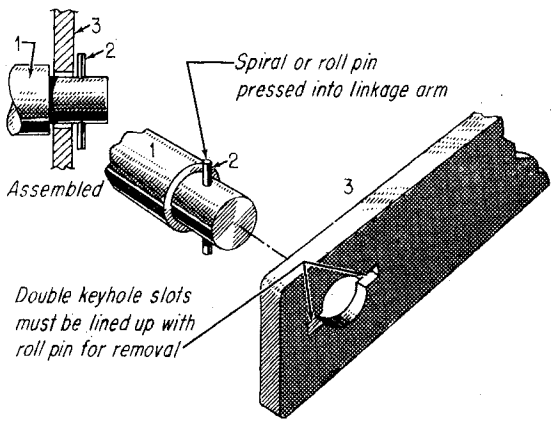
Frank W. Wood JR.





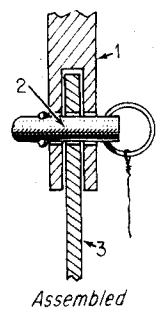
1

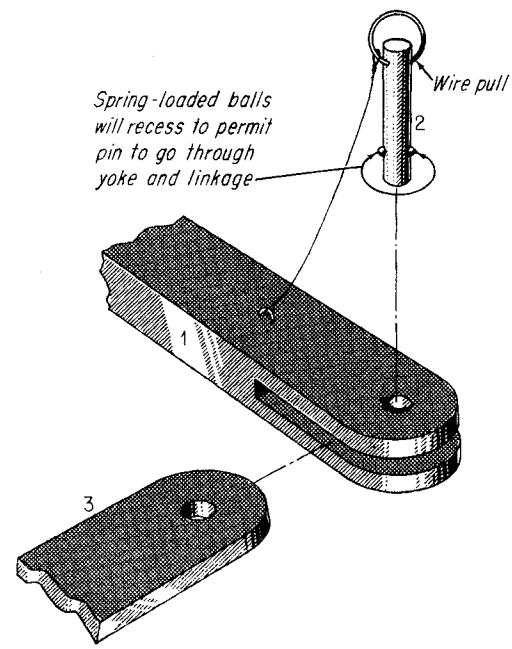
PRELOADED FLAT SPRING lets the connecting rod be adjusted merely by squeezing the end of the clip together to remove grip. This fastening is not recommended for insulated rods.



3

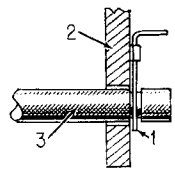
SPECIAL PIN AND DOUBLE KEYHOLE comprise a bayonet type of fastening — reliable only when pinned rod won't turn during operation, when alignment may let pinned arm work free.

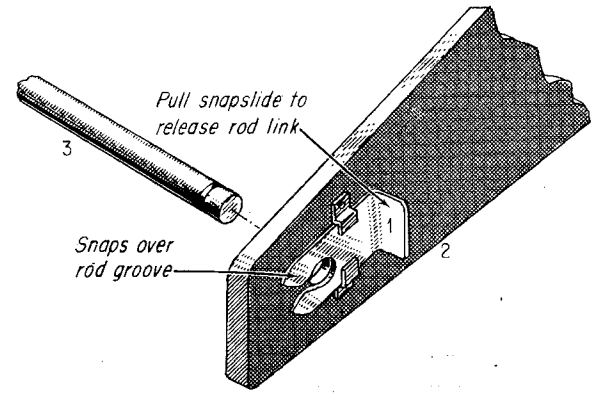




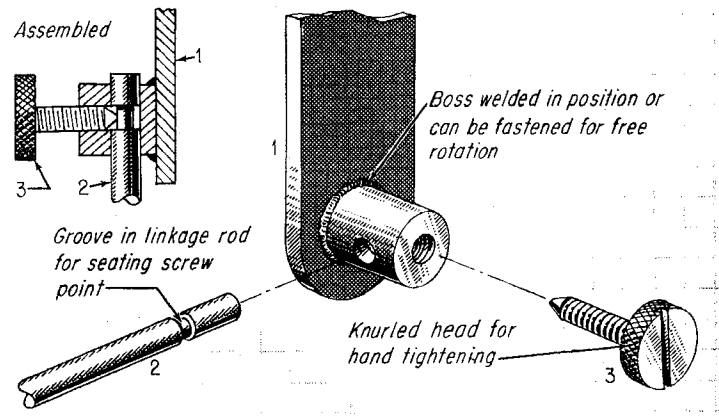
5

YOKE AND SPRING DETENT PIN together make a common fastening method for many mechanisms. It's sometimes wise to tie pin to a member so that the pin will not be lost.

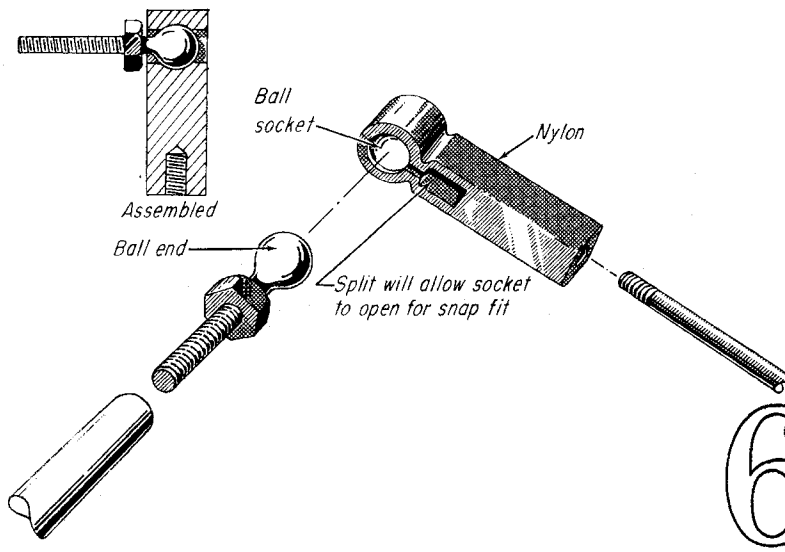




2 **SNAP SLIDE AND GROOVED ROD** provide a fastening method with no loose parts to handle. Snap slide is commercially available, or can be easily fashioned in the model room.



4 **GROOVED ROD AND CLAMP SCREW** will not allow relative movement between rod and other linkage member unless the boss is free to rotate on its arm.

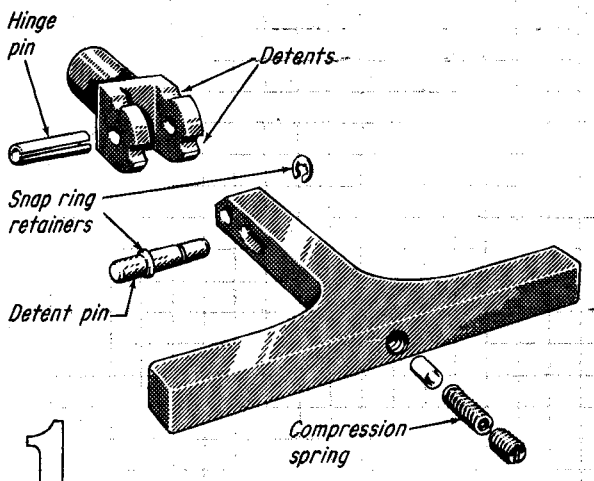


6 **NYLON ROD COUPLER** allows typical ball-and-socket freedom combined with the self-lubricating properties of nylon. If load becomes excessive, the nylon will yield, preventing damage to linkage.

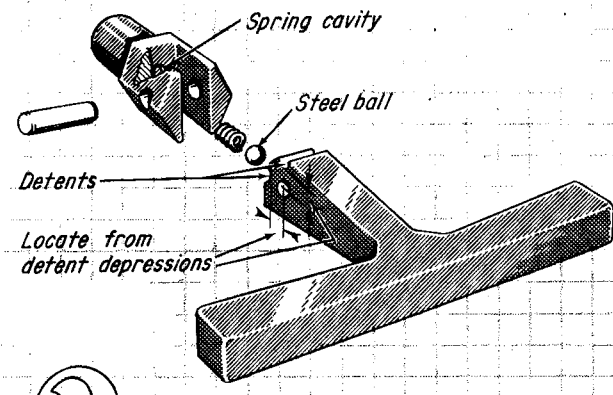
8 Dentents for Clevis Mounting

When handles are mounted in clevises they often need to be held in one or more positions by detents. Here are ways to do this.

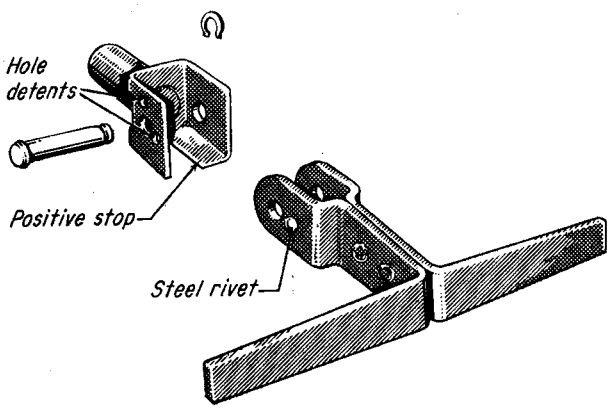
Irwin N. Schuster



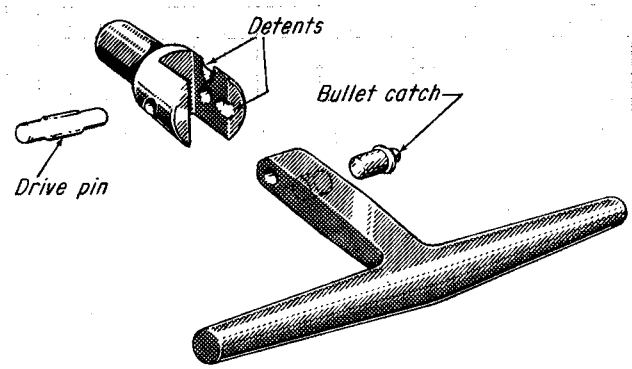
1 **CAST OR MILLED** clevis features an adjustable tensioning device, which varies the follower load. Handle can be extruded section.



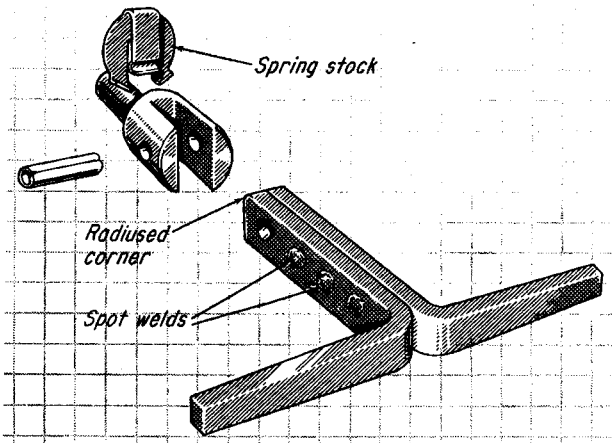
2 **CLEVIS MACHINED** from hexagonal stock can be drilled to receive a ball detent, which acts in cammed surfaces cast in handle.



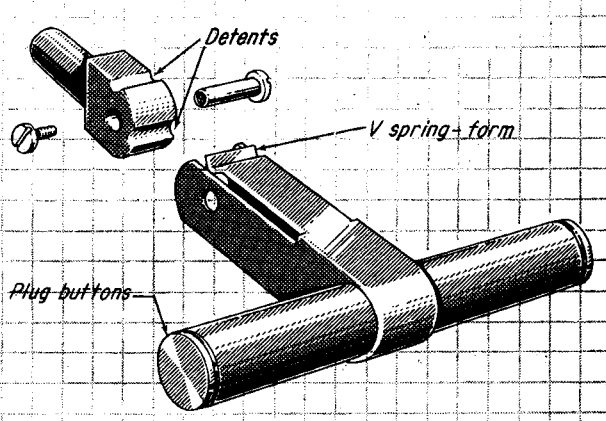
5 **WELDED CLEVIS** is relieved to improve spring characteristics. Punched holes receive steel rivet head which acts as the detent.



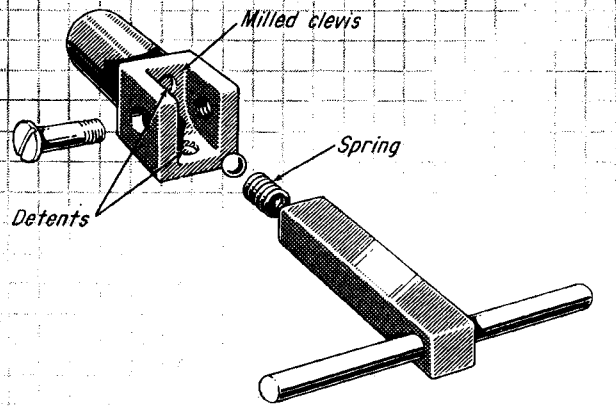
6 **CAST HANDLE** is drilled to accept a commercial "bullet" catch, which detents in the milled internal surface of the clevis flanges.



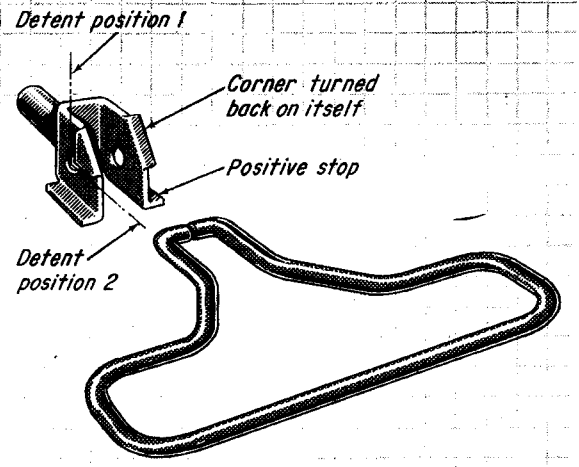
3 **STAMPED SPRING** snaps onto clevis before final assembly and acts as detent against the flat end and top surfaces of metal handle.



4 **TUBE AND SHEETMETAL** clevis handle has integral leaf spring which detents in cammed surface of machined shaft head.



7 **MILLED CLEVIS** accepts ball-bearing follower, actuated by a spring, which seats against a pivot pin in the bar and rod handle.

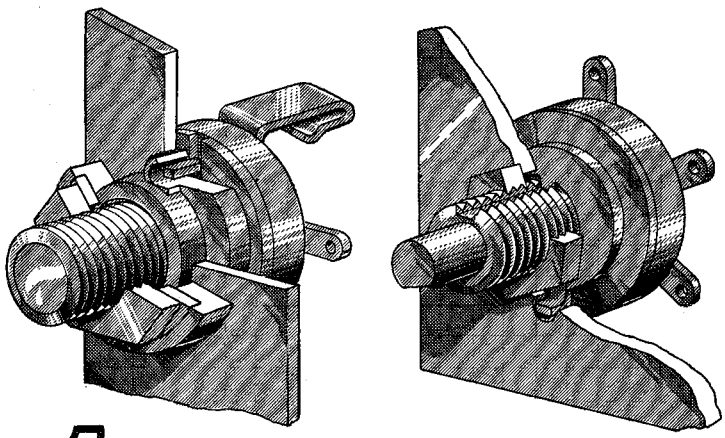


8 **WIRE HANDLE** acts as spring and follower in sheetmetal clevis, in which cammed surfaces and positive stops are made by bending.

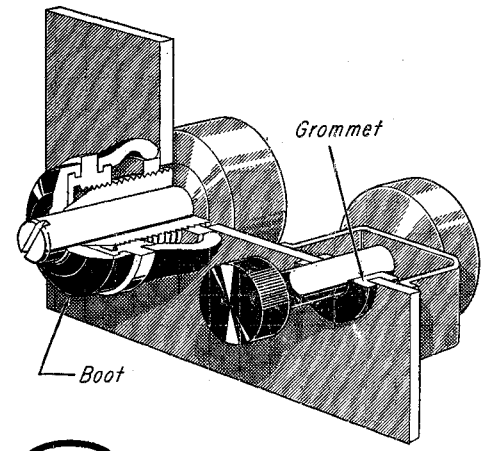
8 Control Mountings

When designing control panels follow this 8-point guide and check for...

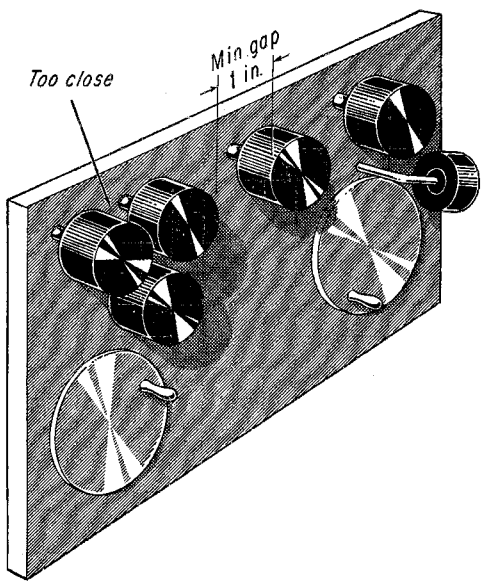
Frank W. Wood JR.



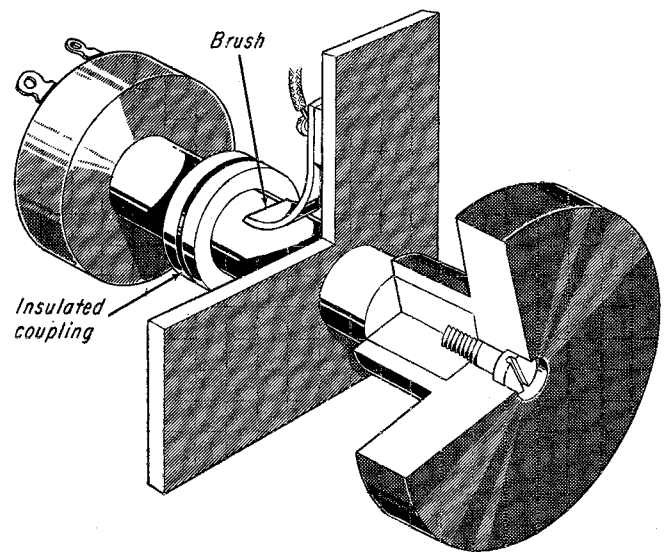
1 **...LOCKING.** Control will stay fixed in spite of vibration or attempts to force shaft too far. Washer at right has two tabs; one fits in the panel, the other in the control bushing. Left washer has a boss which fits into a cutout in the panel and around a pin projecting from the control body.



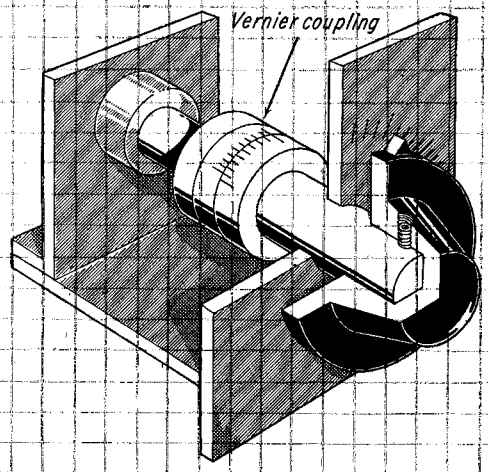
2 **...SEALING** against dust or water. Boot seals between shaft and bushing and between bushing and panel. With control behind panel rubber grommet seals only one place.

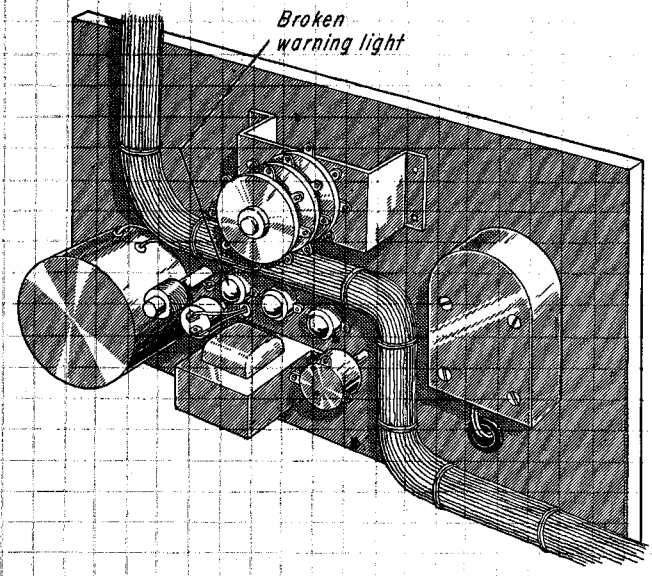


5 **...HAND-ROOM** at front of the panel. Space knobs at least one inch apart. Extending knob to save space puts it where the operator can bump into it and bend the shaft. Best rule is to keep shaft as short as possible.



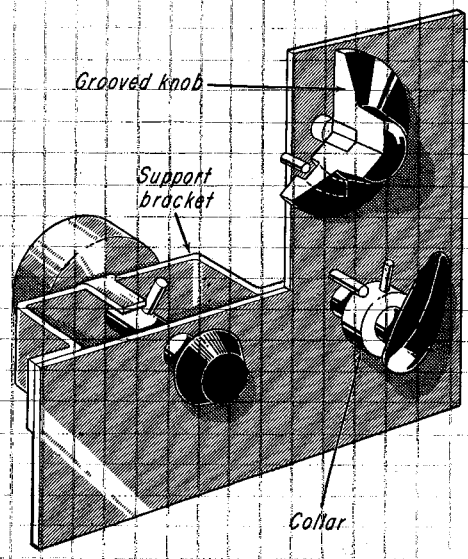
6 **...“HOT” CONTROL KNOBS.** One approach is to ground them by installing a brush against the shaft. Another solution is to isolate the control by an insulated coupling or a plastic knob having recessed holding screws.

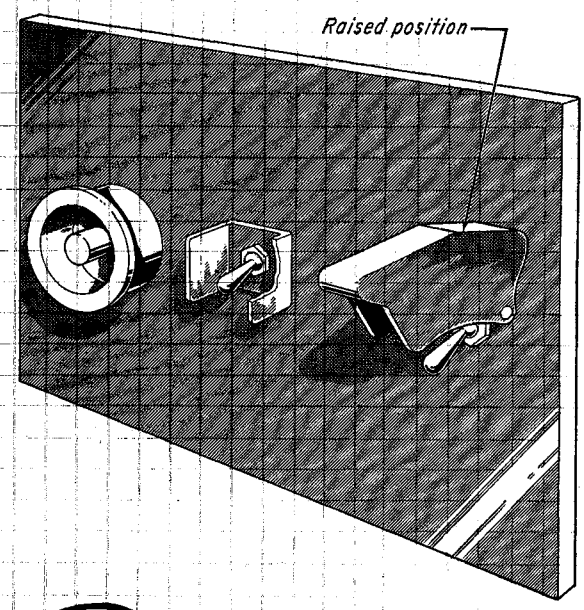




3 **. . . RESETTING** to match controls to panel markings. For crude adjustments a set-screw is enough. Where matching is critical a three-piece vernier coupling permits more accurate calibration.

4 **. . . ACCESSIBILITY** behind the panel. Easy access reduces down time and maintenance costs especially if one man can do most jobs alone. Here, technician can't replace a warning light without dismantling other parts.





7 **. . . LIMIT STOPS** that are strong enough not to bend under heavy-handed use. Otherwise setting will change when stop moves. Collar and grooved knob permit adjustment; tab on bracket doesn't.

8 **. . . GUARDS** to prevent accidental actuation of switches. Bell-shape guard for push-buttons is just finger-size. U-shape guard separates closely spaced toggle switches, and a swinging guard holds down special ones.

18 Ways to Join Honeycomb Panels

A design guide to aid selection among mid-panel and panel-rib joints, spar-panel intersections, and edge-member attachments.

Frank J. Filippi & Boris Levenetz

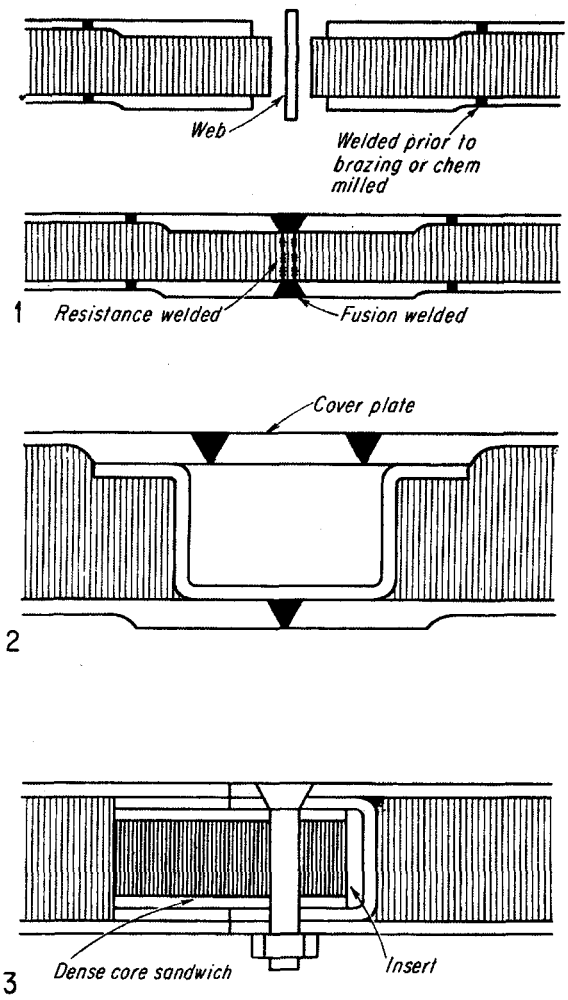
Ever-increasing use of honeycomb-sandwich structures in many different products, including missiles, has revealed a lack of basic design information for these structures. The designer's problem is always: What is the best way to join panels without sacrificing much of their strength?

There are two basic approaches to joint design: The pictorial design approach, used extensively; and the analytic design approach, used less because of lack of time. The pictorial design procedure is mainly concerned with optimizing one type of structure such as honeycomb sandwich. Analytic design seeks to achieve the best load transfer at the lightest weight, irrespective of the type of structure necessary to accomplish the transfer. In this digest the pictorial approach is presented. In any joint design, however, productibility is the major factor influencing final selection. The design engineer must recognize that his skills are currently at the mercy of the production engineer who must reduce the design to a producible article at a reasonable cost.

MID-PANEL JOINT

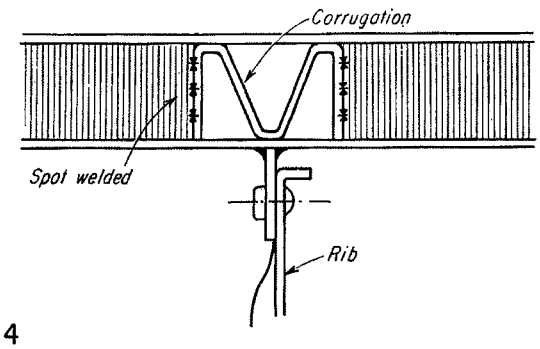
A mid-panel joint must be designed to carry bending, shear, compression, and tension loads. The shear loads require connection of the panel cores, since the core is the only element able to transmit shear forces perpendicular to the panel. For applications not involving shear loads, joining the cores is not mandatory, but is very desirable for joint stabilization. The ideal joint would have cores and faces welded together, providing necessary ties for proper load transfer. It can not, however, be produced because of inaccessibility of the core for welding. A producible and analytically satisfactory joint, Fig. 1, shows the joint before the welding operation as prepared for joining. The now-accessible core is welded to the web, the joint is closed, and a fusion weld picks up the faces and web. The addition of the web guarantees a good shear joint for the core, while the thickened facing compensates for the loss in strength from the fusion welding operation. Although some deformation of the core is encountered, good shear transfer is still possible.

Much of the brazed honeycomb sandwich manufactured today is made from precipitation-hardenable stainless steels. As a result of heat treatment, these steels exhibit a net growth averaging 0.004 in. per in. Unfortunately, the fact that this growth is neither consistent nor exactly



predictable results in dimensional discrepancies of the heat-treated parts. Machining a panel edge before welding gives a measure of compensation for erratic growth and should be considered as necessary design practice along at least two adjacent edges of any precipitation-hardenable steel sandwich.

Where welding access is from one side only, the joint



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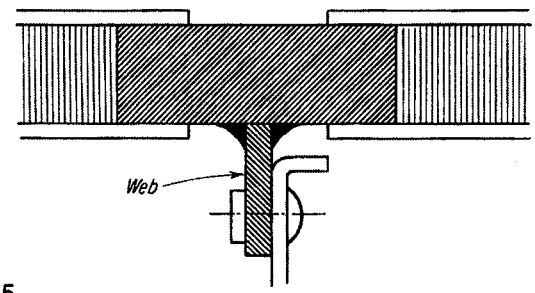

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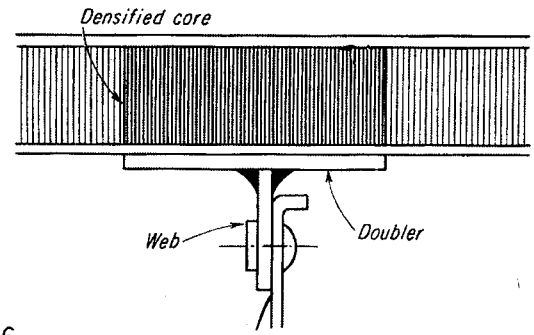

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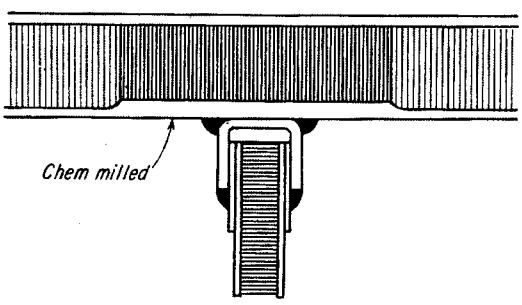

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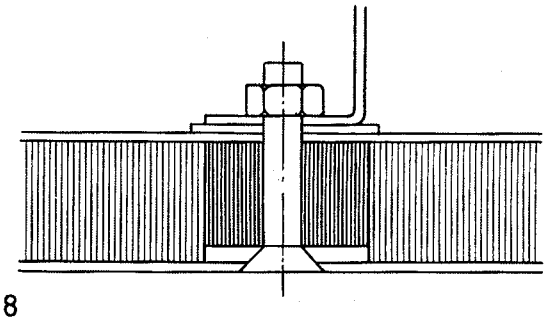

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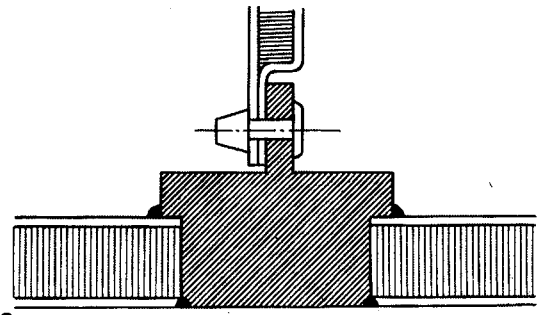

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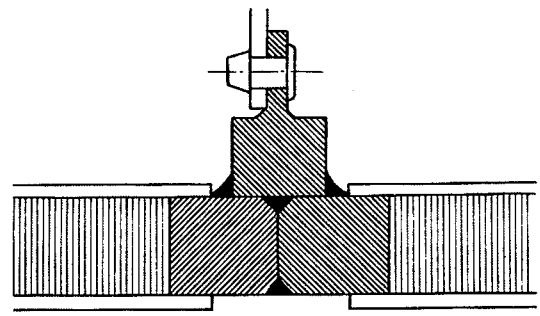

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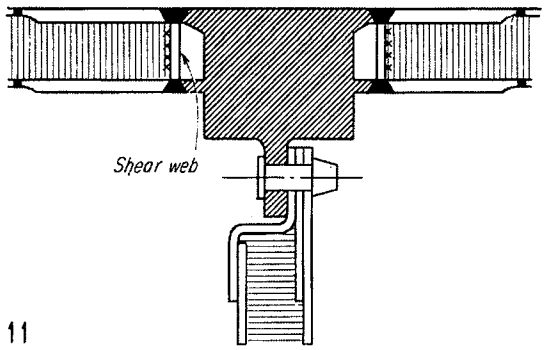
becomes more cumbersome. A solution is presented in Fig. 2 that is satisfactory except for the incumbent weight penalty. The panels are brazed with the edge members extended beyond the net part size and trimmed to final size. Within limits, growth compensation is possible with this joint. Welding the cover plate to the panels as the last operation completes the joint.

A mechanical joint, admittedly heavier yet, is shown in Fig. 3. Essentially a tongue-and-groove joint, the tongue portion is a sandwich bar of densified core, its faces designed to carry the longitudinal loads of the panels. The bar may be mechanically attached, or brazed in place as shown. The mating portion of the joint is brazed with a U-channel edge member through which the mechanical attachment is made.

PANEL-RIB JOINT

The panel-rib joint must maintain the integrity of the original panel and transfer any additional loads, in most cases a shear-flow, from the rib into the panel, where this load is distributed between both faces. Fig. 4 shows a



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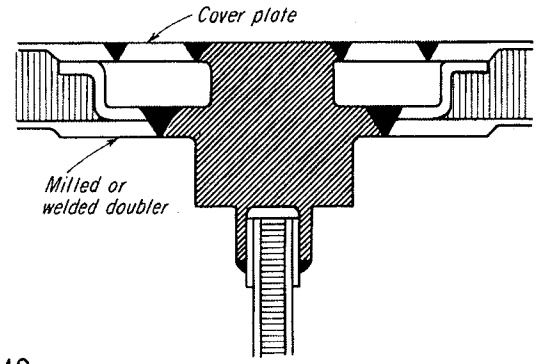

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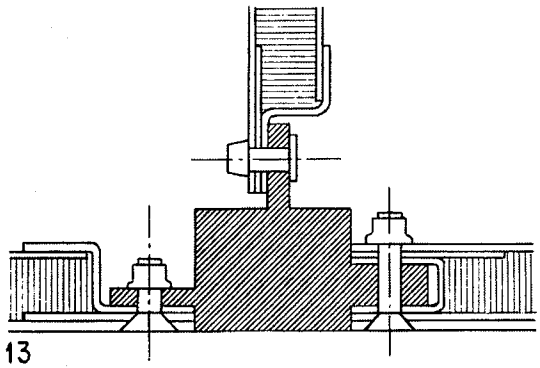

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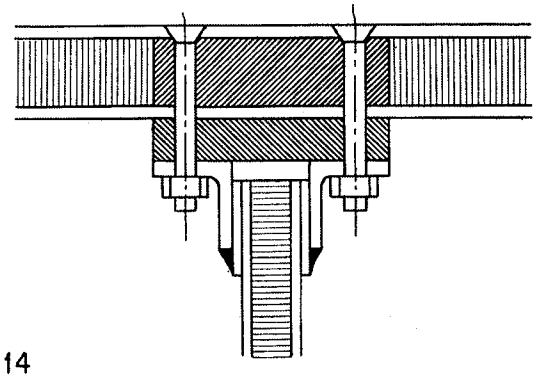

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joint which theoretically would meet these requirements. The corrugation transfers the rib loads into the outer face of the panel and also makes a link between the honeycomb cores. This joint is plainly difficult to produce because of the accessibility and welding problems. The solution shown in Fig. 5 would be easy to make but extremely inefficient because of the discontinuity of the faces.

The design in Fig. 6 meets design requirements and is producible. It is best to make the brazed joint without the web, then attach it by subsequent welding. The panel then becomes essentially flat, greatly simplifying the braze fixturing and production sequence. The doubler shown on the drawing may be seamwelded, brazed, or chemically milled as an integral part of the facing. A variation of this design, Fig. 7, shows attachment of a honeycomb sandwich rib to the panel. The U-channel is welded to both pieces to effect the joint with a minimum of manufacturing problems.

A mechanical joint, if acceptable for the application, is quite simple, as shown in Fig. 8. The rib is directly attached to a densified core insert which provides reinforcement for the countersink and for the bolt-crushing forces. The doubler between rib flange and panel provide better distribution of compression and shear loads.

SPAR-PANEL INTERSECTION

The function of this joint is to transmit shear loads from the panels into the spar and to assist the spar in carrying the bending loads by loading an effective width of the panel in tension or compression. The theoretical joint in Fig. 9 incorporates all necessary elements for correct load transfer. Unfortunately, the unreasonable welding requirements make it almost impossible to produce with current knowledge. The production people would prefer to make the joint as shown in Fig. 10. The limitation of this design is the inability to satisfactorily vary the spar cross-section as loading changes.

A good design is one that incorporates an independently produced spar to which the panels are welded, Fig. 11. A shear web is introduced between the sandwich and the spar as previously discussed before the elements are welded together. This layout shows a honeycomb sandwich spar web riveted to the spar caps with high-shear rivets. If welding from one side only is necessary a method similar to one previously described (4) is applicable, as shown in Fig. 12. The shear transfer is over the short flange of the edge member and cap flange which must have the rigidity to take the shear load in bending. The cover plate takes forces only in the plane of the outer facing sheet.

Again reverting to a mechanical joint, Fig. 13 is a composite of two types of panel connection to the spar cap. The double joint takes all kinds of loads effectively, while the single joint is able to take shear perpendicular to the panel and loads in the panel of the outer panel facing only. Another interesting variation of a mechanical spar joint enables a simplified approach to joining the

(12)—**Pivoted Joints** . . . Method at left is satisfactory for low-cost consumer products where some binding can be tolerated until the joint works in. The one shown second from the left is perhaps best, because there is some small clearance between the rivet head and the wall.

(13)—**Washers** . . . If a metallic section is to be assembled to a softer material, a washer may be necessary to provide the necessary rigidity for clinching action. The soft material should be outside with the washer under the rivet head. For conventional assemblies either way is practical.

(14)—**Tight Joints** . . . Since blind rivets exert considerable gripping force when clinched, the joint shown second from left is impractical. Conversely, either of examples in which a single rivet is employed may prove as satisfactory as the one with multiple rivets.

(15)—**Multiple Assemblies** . . . One, two or more components or sections can be riveted to a base or panel with a single rivet, provided they can be mounted from the front, or the base section is accessible from the rear or underneath.

(16)—**Straps and Clamps** . . . A blind rivet can be used to assemble straps, clamps, and similar members around a component. Allowance must be made for the squeezing action on the clamp.

(17)—**Housings and Panels** . . . Of the many ways to construct a housing or panel, the ones shown here are perhaps the most common. Examples: left—a double-channel section forming the joint to which the panels are assembled and riveted; center—a back-up stringer with a finishing strip inserted between mating panels; right—a base angle with riveted panels and a finishing strip between the gap. In selecting the design, consider cost, appearance, strength and thermal expansion.

(18)—**Weatherproof Joints** . . . It's difficult to produce a pressure-tight riveted joint, but reasonably moisture resistant, weather-tight assemblies have been evolved.

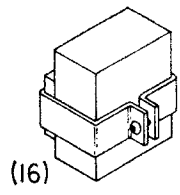
(19)—**Extruded Sections** . . . Blind riveting is common, because of the limited access and clearances in most extruded sections. Rigidity of the joint at right is far greater than that at left. Setting against unsupported internal projections is seldom recommended.

(20)—**Compressible Materials** . . . Compressible materials do not provide a firm base for the setting action, and the rivet may tear through. Use of a formed sleeve or bushing, or a washer and back-up plate can solve this problem.

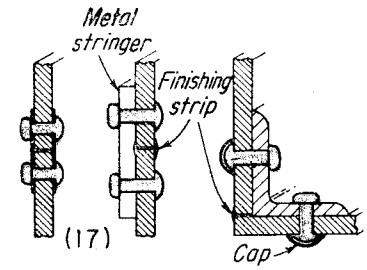
(21)—**Tubing** . . . For maximum rigidity, the rivet should not extend through both walls of tubular members. The rivet will set blind against the curved inner wall section, or the tubing can be flattened to increase the contact area.

(22)—**Plastic Members** . . . Preferably, the rivet should be set against a metallic rather than a plastic member. However, the rivets are being set successfully against many molded and extruded plastics, which resist setting pressure without cracking.

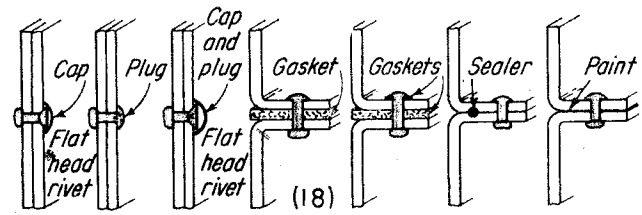
(23)—**Blind Holes or Slots** . . . Clinching the rivet against the side of a blind hole or into and against a milled slot, intersecting hole, or internal cavity is possible because of the clinching action of the rivet.



STRAPS AND CLAMPS



HOUSINGS AND PANELS



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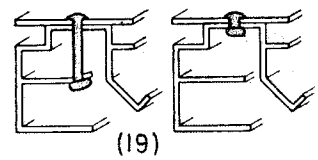
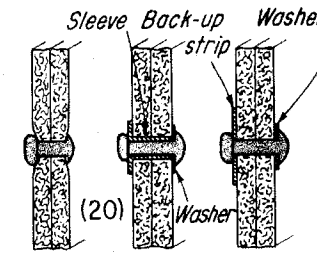
WEATHERPROOF JOINTS



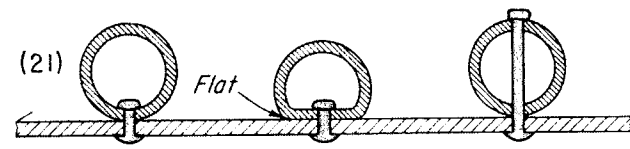
Unsatisfactory Good

EXTRUSIONS



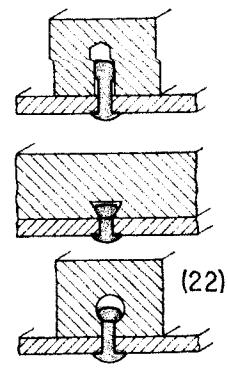
Unsatisfactory Good Good

COMPRESSIBLE MATERIALS

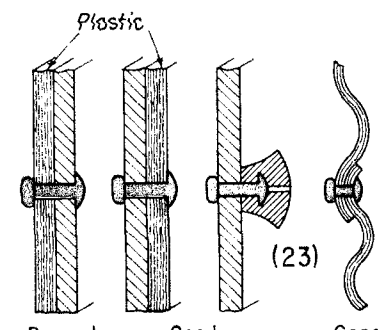


Good Good Unnecessary

TUBING



BLIND HOLES AND SLOTS



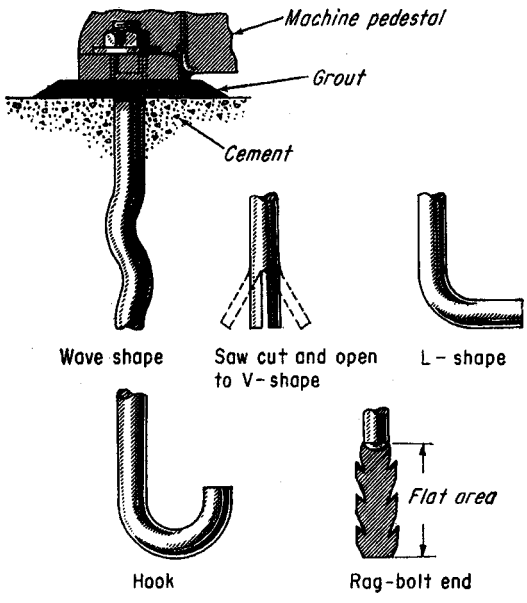
Depends on Material Good Good

PLASTICS

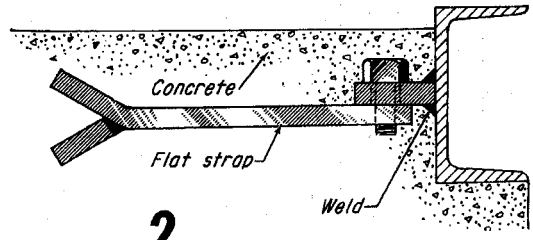
12 Ways to Anchor Heavy Machines

Machine design is not really finished until anchoring and leveling methods have been decided. Here's a selection from which to choose.

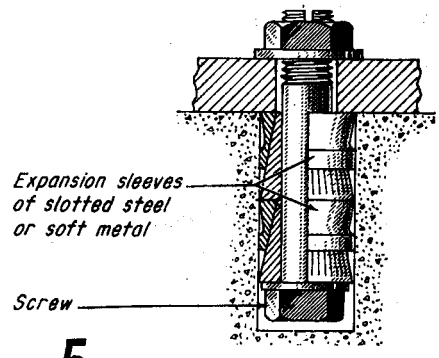
Louis Dodge



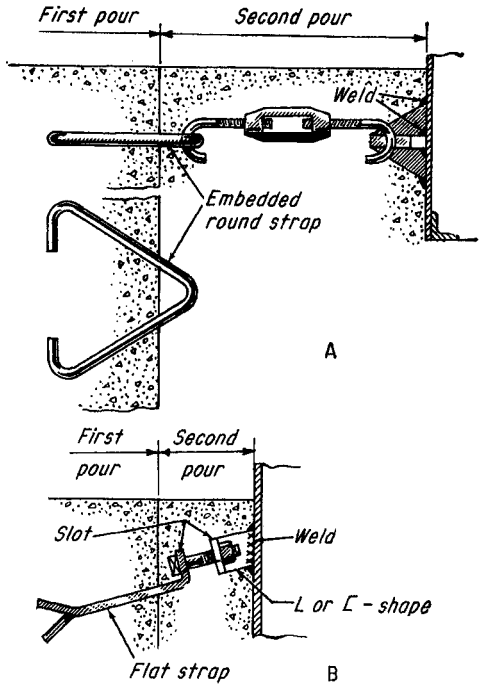
1. ANCHOR BOLT AND ALTERNATIVE ENDS



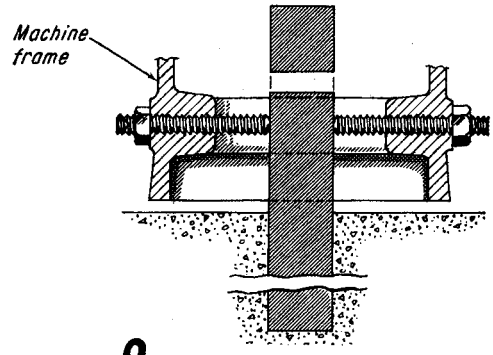
2. ANCHOR STRAP



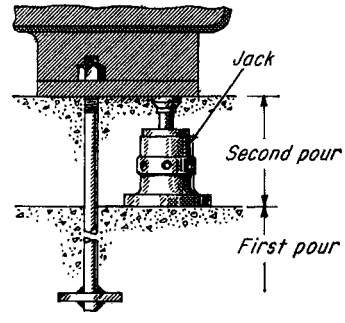
5. EXPANSION-SLEEVES



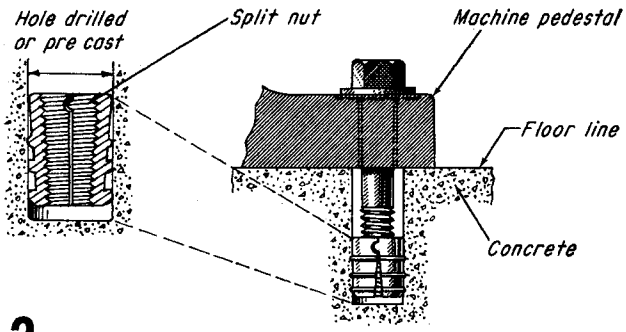
7. TURNBUCKLE ANCHOR (A). ADJUSTMENT-BOLT ANCHOR (B).



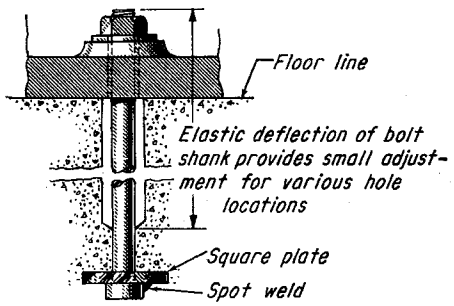
8. LATERAL-ALIGNMENT ANCHOR



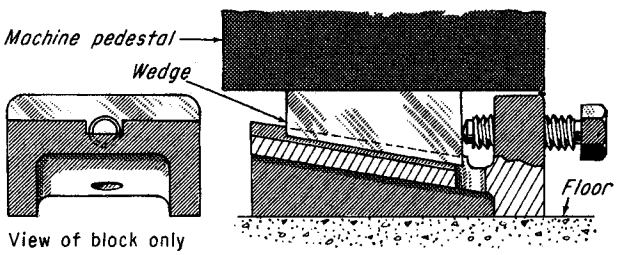
10. ALIGNING JACK AND ANCHOR BOLT



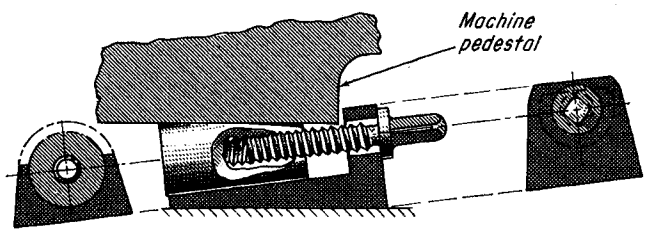
3. SPLIT ANCHOR-NUT WITH WEDGE ACTION


Floor line
Elastic deflection of bolt shank provides small adjustment for various hole locations
Square plate
Spot weld

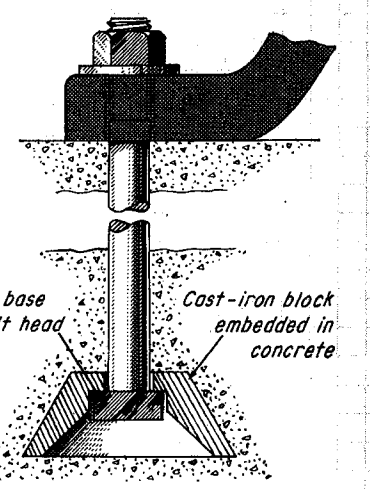
6. ANCHOR BOLT FOR LOCATION ADJUSTMENT



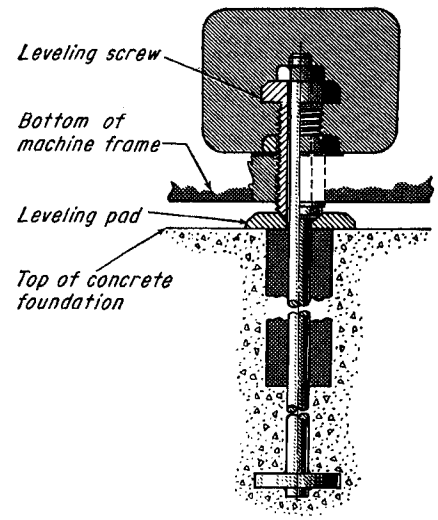
9. WEDGE-BLOCK LEVELING



11. CYLINDRICAL WEDGE BLOCK FOR UNEVEN OR SLOPING FLOORS

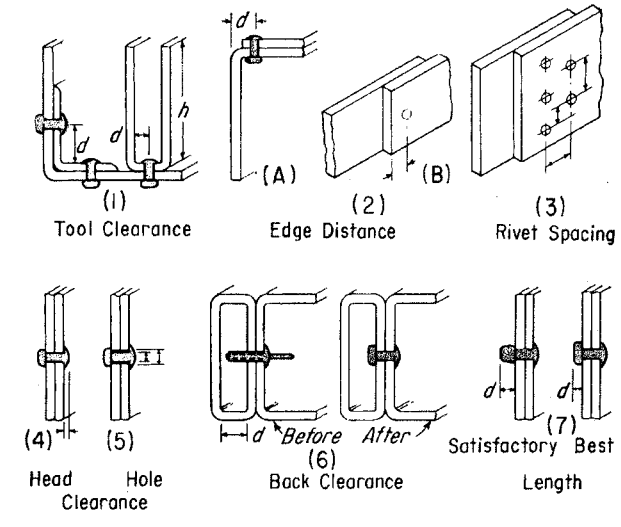


4. EMBEDDED ANCHOR BLOCK

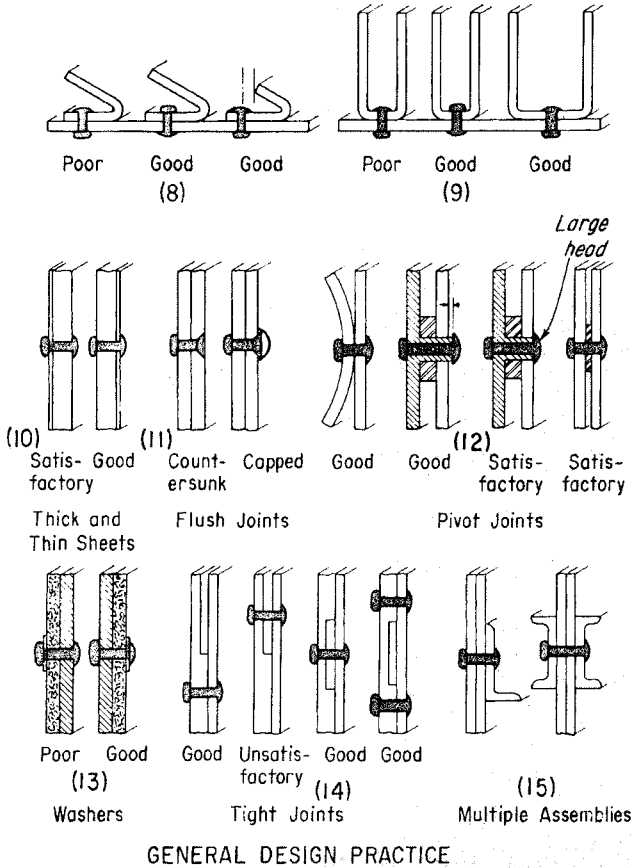


12. LEVELING SCREW WITH ANCHOR BOLT

Design Details of Blind Riveted Joints



CLEARANCES AND ALLOWANCES



GENERAL DESIGN PRACTICE

Clearances and Allowances

(1)—**Tool Clearance** . . . Minimum allowable distance from a wall or projection to the rivet-hole centerline is critical, should be checked against tool specifications. Depth of a channel or cylindrical section likewise limits the application if the rivet is inserted as shown. However, tool extensions can often be employed, and the nosepiece of the tool can be extended by as much as an inch.

(2)—**Edge Distance** . . . From the standpoint of joint strength, the recommended distance from the rivet centerline to the edge of a sheet should not be less than twice the rivet diameter. If joint strength is secondary, this dimension can be greatly reduced. Example: the rivet functions only to hold a bracket or component in position.

(3)—**Rivet Spacing** . . . This also is a function of application and strength requirements.

(4)—**Head Clearance** . . . Standard head dimensions vary with rivet size. Height and diameter can readily be determined from specification sheets. Frequently, the work can be countersunk, or the joint designed to prevent interference with mating sections.

(5)—**Hole Clearance** . . . Permissible clearance depends on whether the fastener grips the wall or clinches underneath. In the latter case, oversized holes are less critical, and one does not depend on wall constriction to prevent breakout.

(6)—**Back Clearance** . . . Distance from flat of the head to end of the unclinched rivet determines the required back clearance—not dimensions after setting. These values should take into account the maximum combined material thicknesses.

(7)—**Rivet Length** . . . There is a delicate balance between joint thickness, mandrel-head dimensions, the cold-working properties of the rivet material and, of course, the shank diameter of a blind rivet. On the other hand, one length can be used for a wide range of panel thicknesses. For any use beyond the tabulated data, actual limitations should be determined by test.

General Design

(8)—**Angles and Formed Sections** . . . Avoid obstructions to the tool, which should set flush on the work. Thus, the "poor" joint requires a special offset tool, may still be inaccessible. Reverse the rivet and set from the other side, or reduce the length of the angular section.

(9)—**Channel Sections** . . . For adequate tool clearance, set from the underside of the channel or widen the section. A tool extension may be used to reach inside the section, but makes the tool somewhat more awkward to handle.

(10)—**Thick and Thin Sheets** . . . If there's a choice, it's best to set the rivet against the thicker material. Rivets of this type can be set against 0.030 in. and thinner aluminum stock.

(11)—**Flush Joints** . . . A truly flush surface can be obtained only by countersinking the outer wall or plate. Dimpling generally is not recommended because of the possibility of the rivet not fully "bottoming" and setting against the hole edge. A smooth, watertight, but not completely flush surface is obtained by countersinking and capping the rivet.

(12)—**Pivoted Joints** . . . Method at left is satisfactory for low-cost consumer products where some binding can be tolerated until the joint works in. The one shown second from the left is perhaps best, because there is some small clearance between the rivet head and the wall.

(13)—**Washers** . . . If a metallic section is to be assembled to a softer material, a washer may be necessary to provide the necessary rigidity for clinching action. The soft material should be outside with the washer under the rivet head. For conventional assemblies either way is practical.

(14)—**Tight Joints** . . . Since blind rivets exert considerable gripping force when clinched, the joint shown second from left is impractical. Conversely, either of examples in which a single rivet is employed may prove as satisfactory as the one with multiple rivets.

(15)—**Multiple Assemblies** . . . One, two or more components or sections can be riveted to a base or panel with a single rivet, provided they can be mounted from the front, or the base section is accessible from the rear or underneath.

(16)—**Straps and Clamps** . . . A blind rivet can be used to assemble straps, clamps, and similar members around a component. Allowance must be made for the squeezing action on the clamp.

(17)—**Housings and Panels** . . . Of the many ways to construct a housing or panel, the ones shown here are perhaps the most common. Examples: left —a double-channel section forming the joint to which the panels are assembled and riveted; center —a back-up stringer with a finishing strip inserted between mating panels; right—a base angle with riveted panels and a finishing strip between the gap. In selecting the design, consider cost, appearance, strength and thermal expansion.

(18)—**Weatherproof Joints** . . . It's difficult to produce a pressure-tight riveted joint, but reasonably moisture resistant, weather-tight assemblies have been evolved.

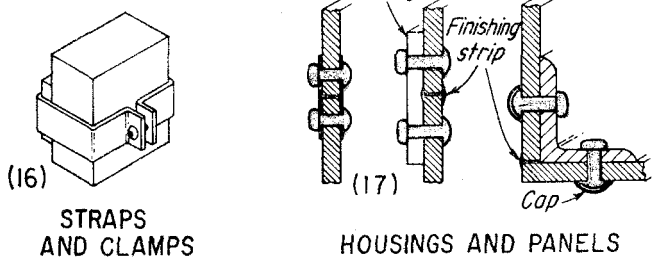
(19)—**Extruded Sections** . . . Blind riveting is common, because of the limited access and clearances in most extruded sections. Rigidity of the joint at right is far greater than that at left. Setting against unsupported internal projections is seldom recommended.

(20)—**Compressible Materials** . . . Compressible materials do not provide a firm base for the setting action, and the rivet may tear through. Use of a formed sleeve or bushing, or a washer and back-up plate can solve this problem.

(21)—**Tubing** . . . For maximum rigidity, the rivet should not extend through both walls of tubular members. The rivet will set blind against the curved inner wall section, or the tubing can be flattened to increase the contact area.

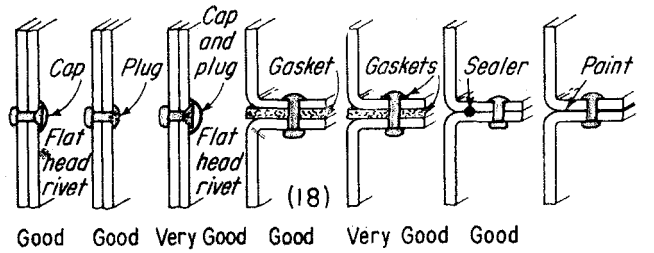
(22)—**Plastic Members** . . . Preferably, the rivet should be set against a metallic rather than a plastic member. However, the rivets are being set successfully against many molded and extruded plastics, which resist setting pressure without cracking.

(23)—**Blind Holes or Slots** . . . Clinching the rivet against the side of a blind hole or into and against a milled slot, intersecting hole, or internal cavity is possible because of the clinching action of the rivet.

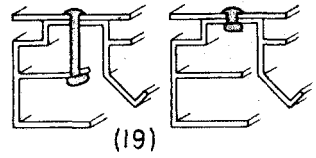


STRAPS AND CLAMPS

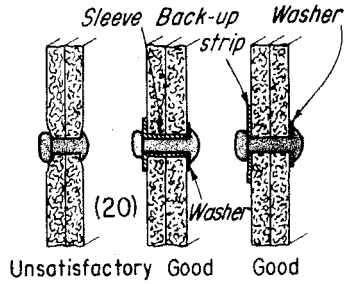
HOUSINGS AND PANELS



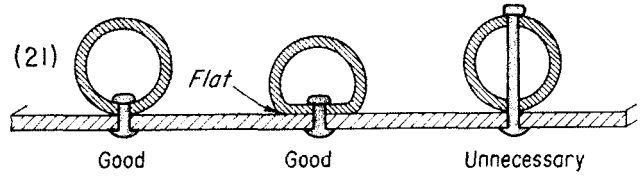
WEATHERPROOF JOINTS



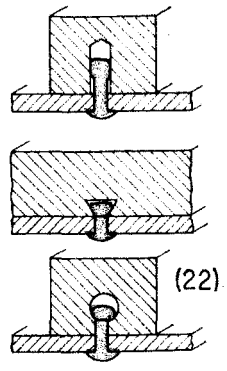
EXTRUSIONS



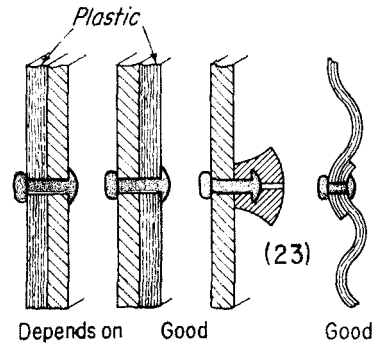
COMPRESSIBLE MATERIALS



TUBING



BLIND HOLES AND SLOTS



PLASTICS